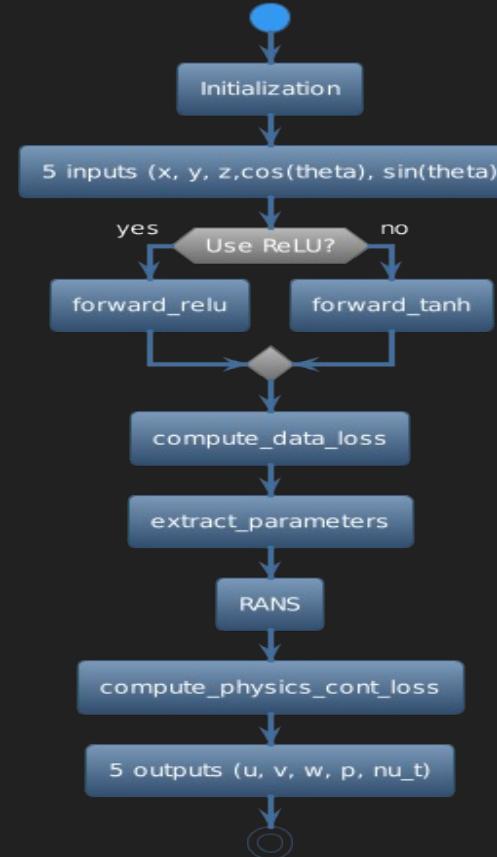
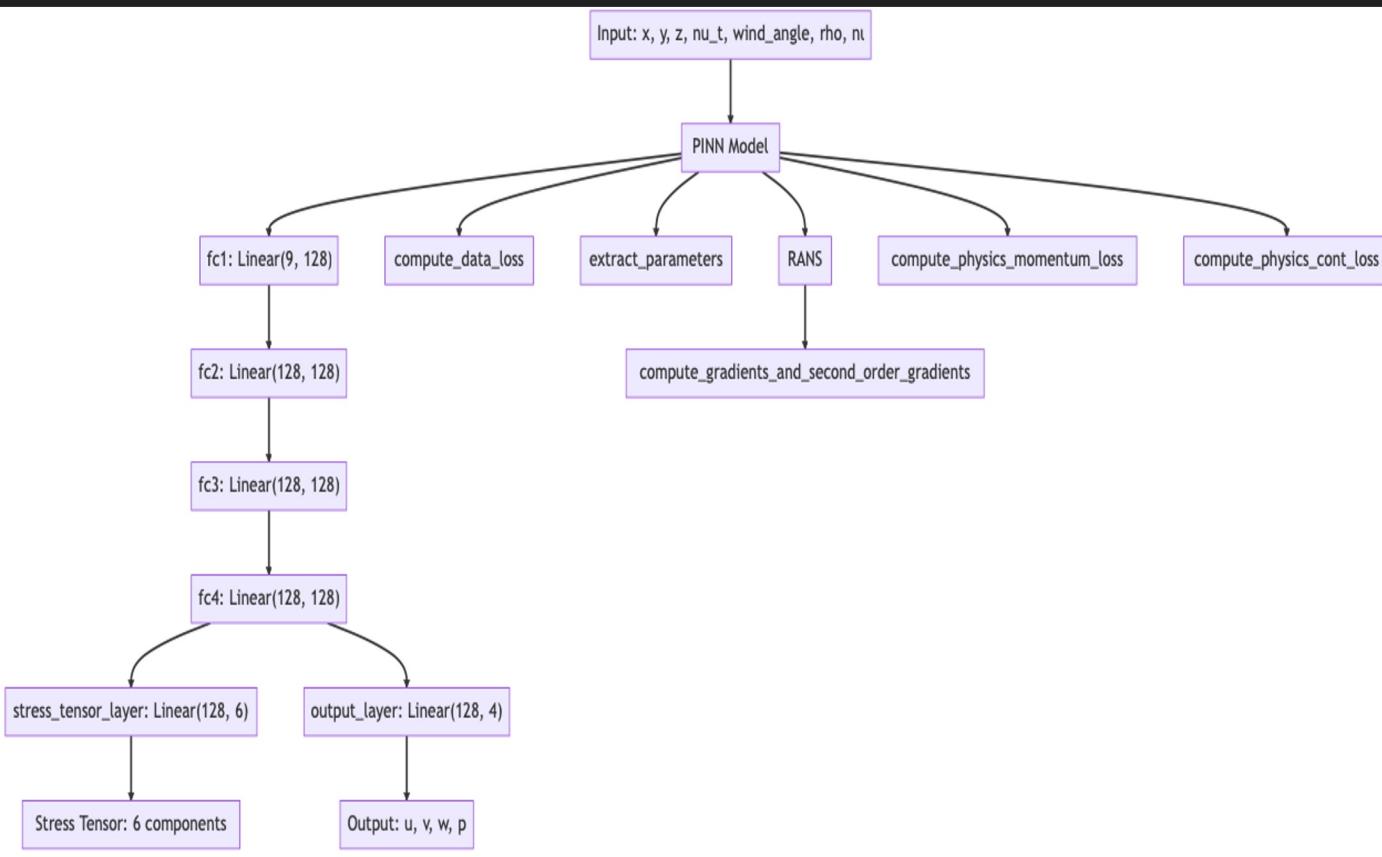


# PM003 – 25\* October 2022

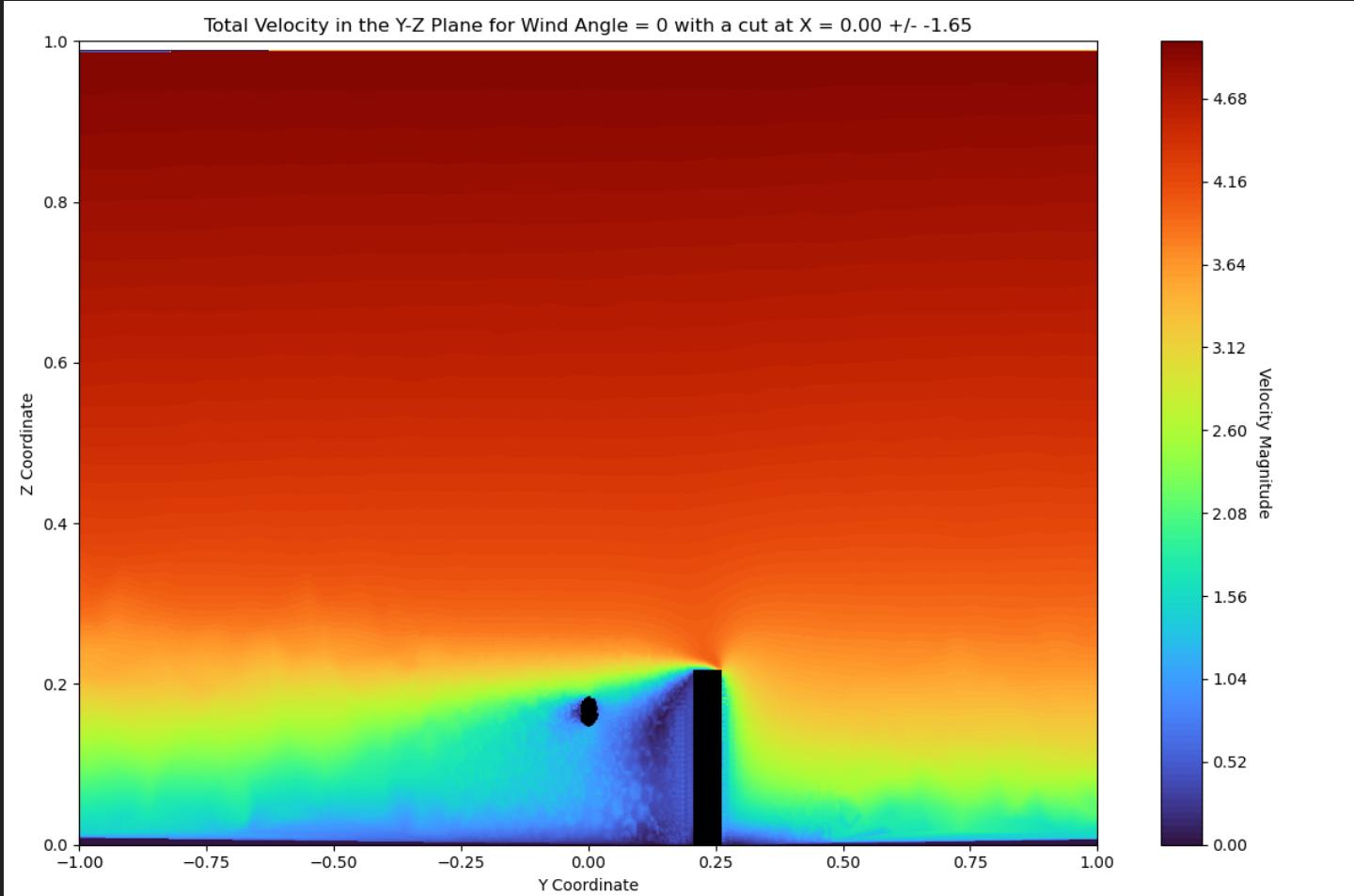
## Update on PINNs

Application to Urban Wind Field Dispersion Studies

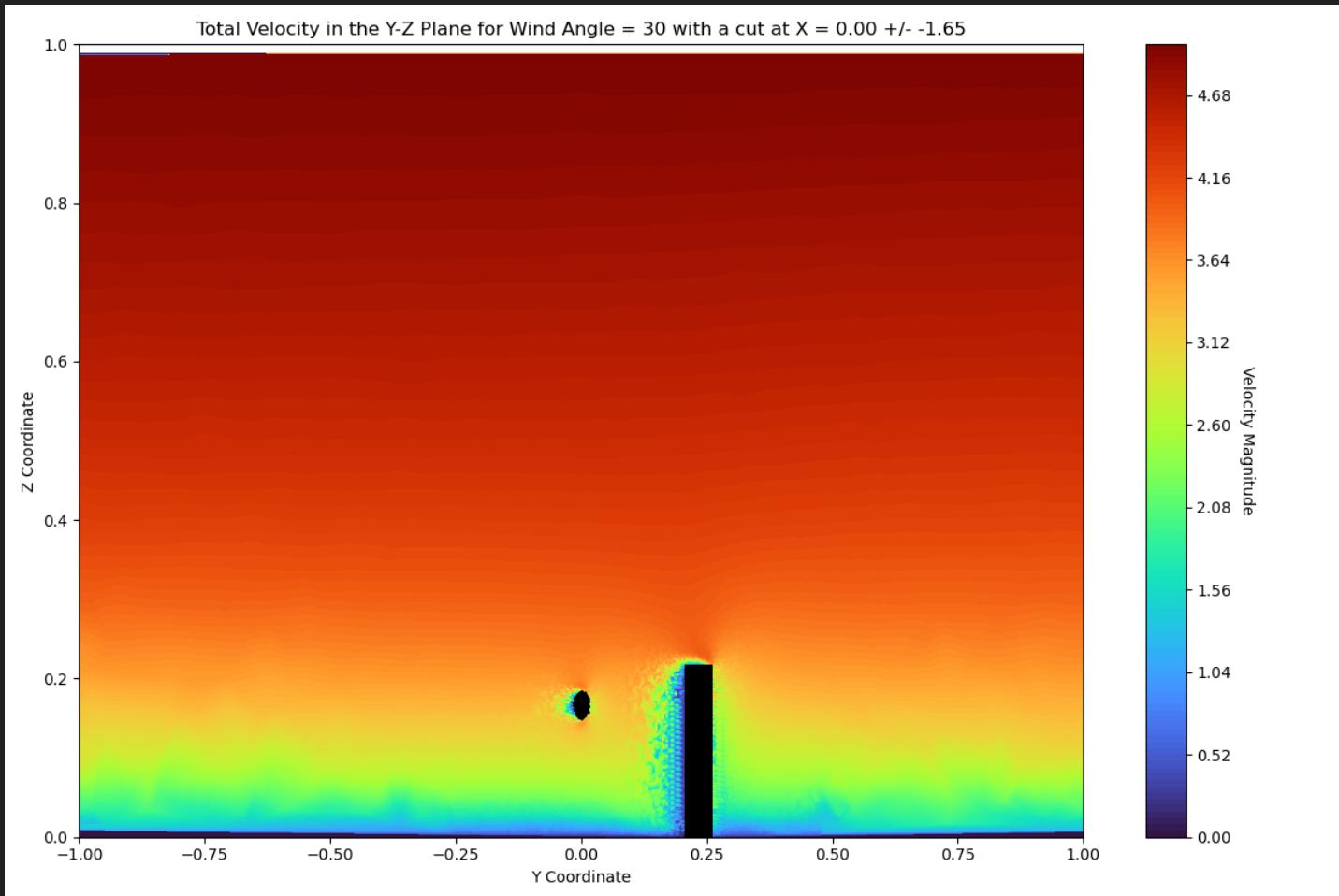
# Neural Network Architecture – Previous vs Updated



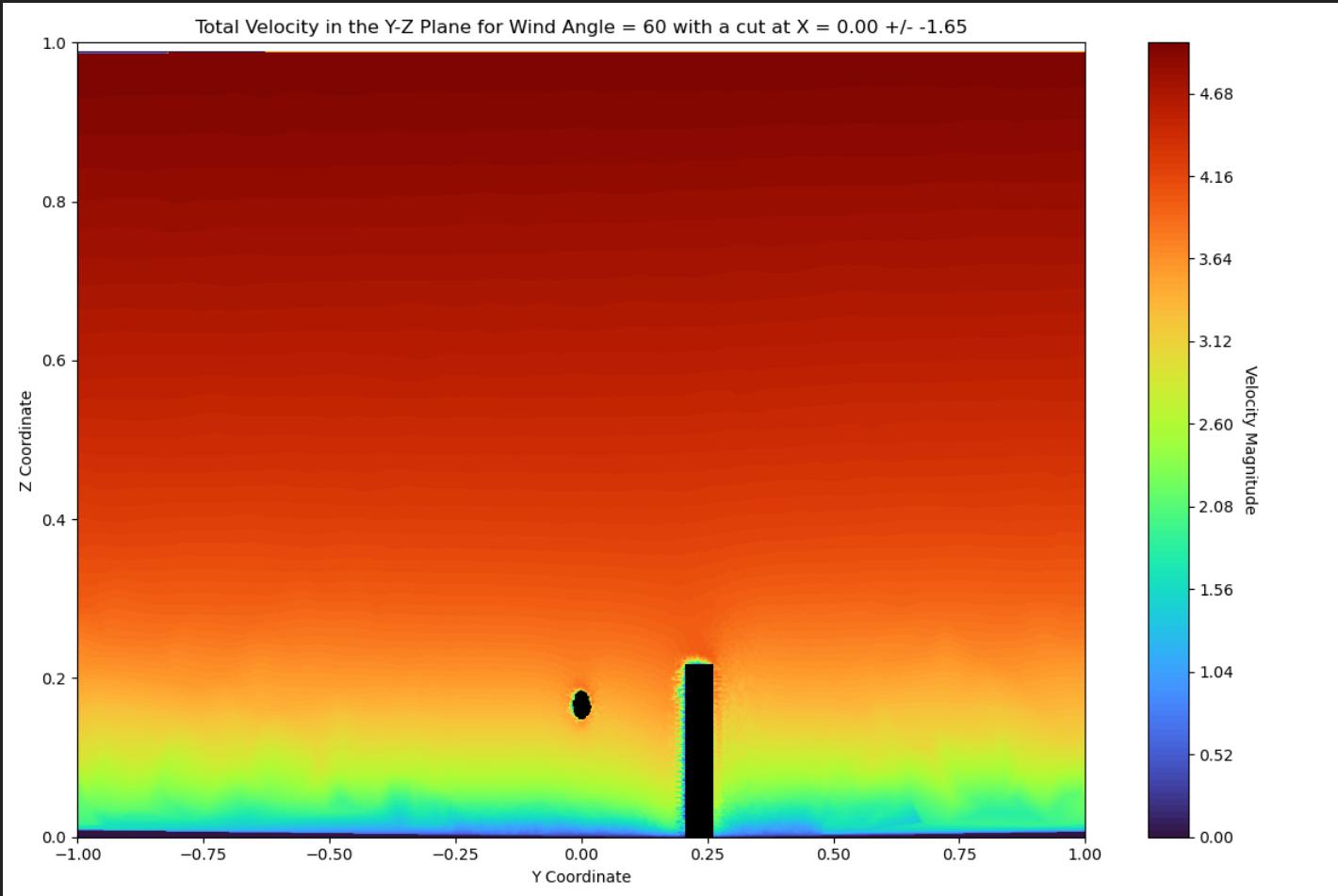
# Data Plots – wind angle = 0



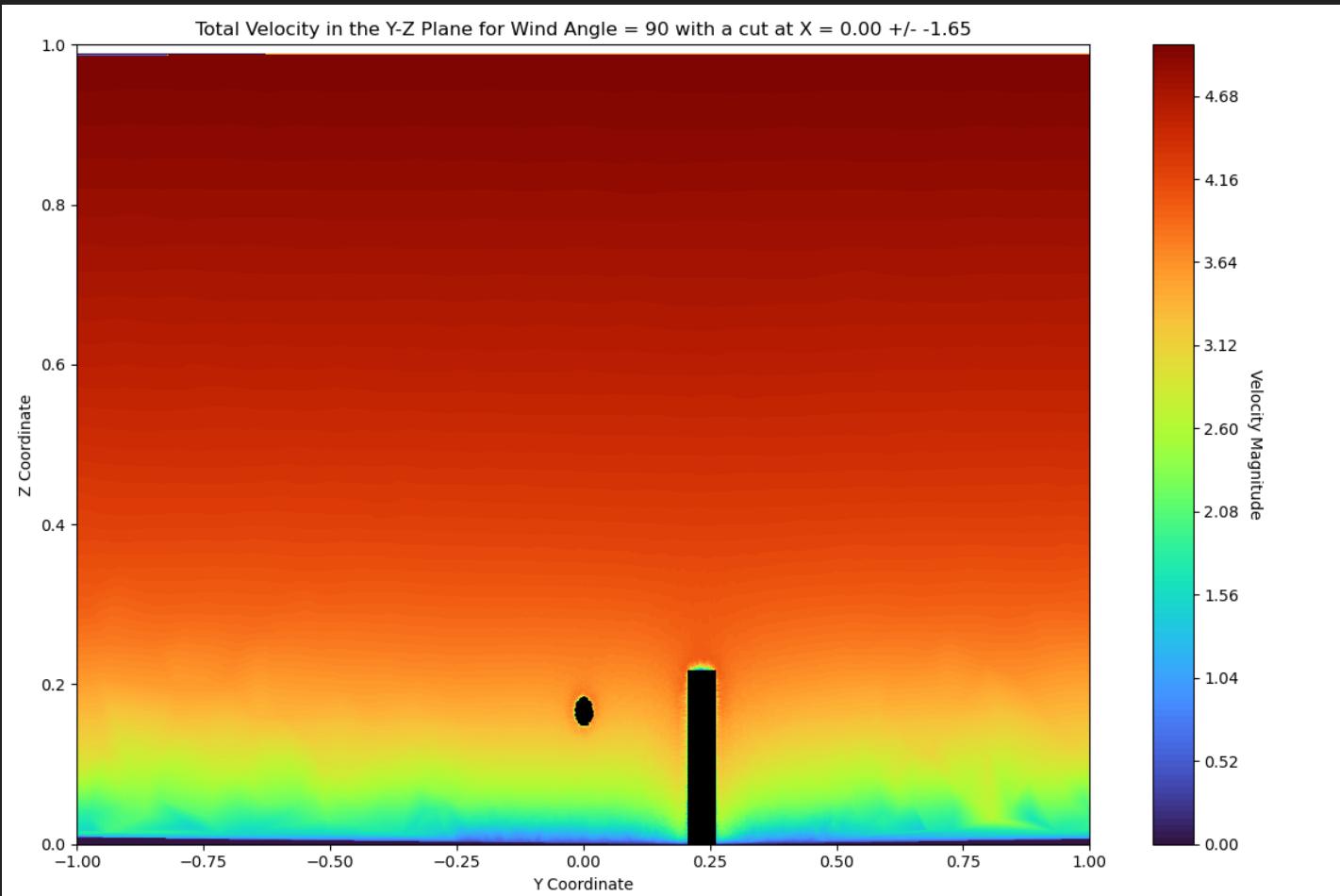
# Data Plots – wind angle = 30



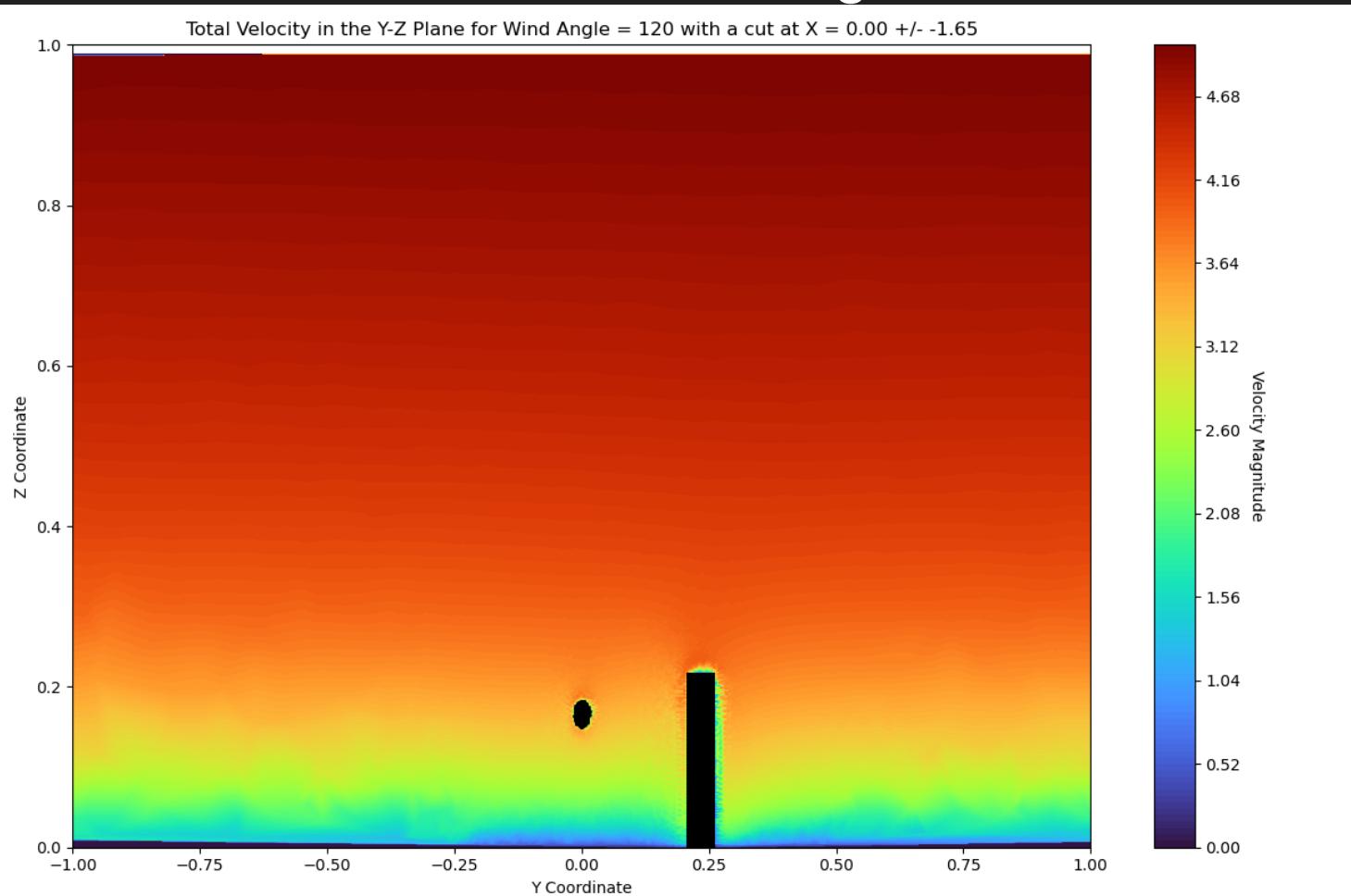
# Data Plots – wind angle = 60



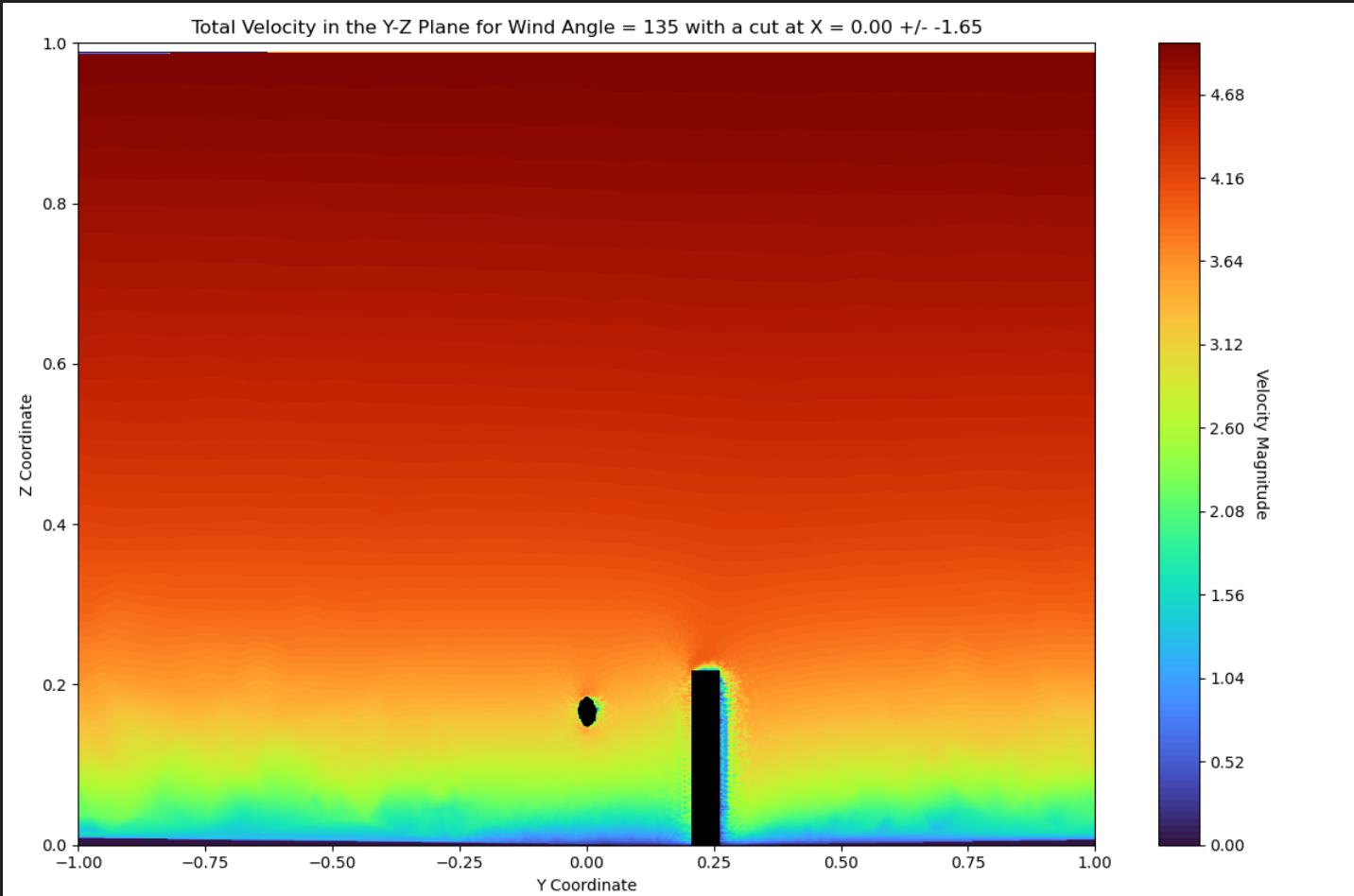
# Data Plots – wind angle = 90



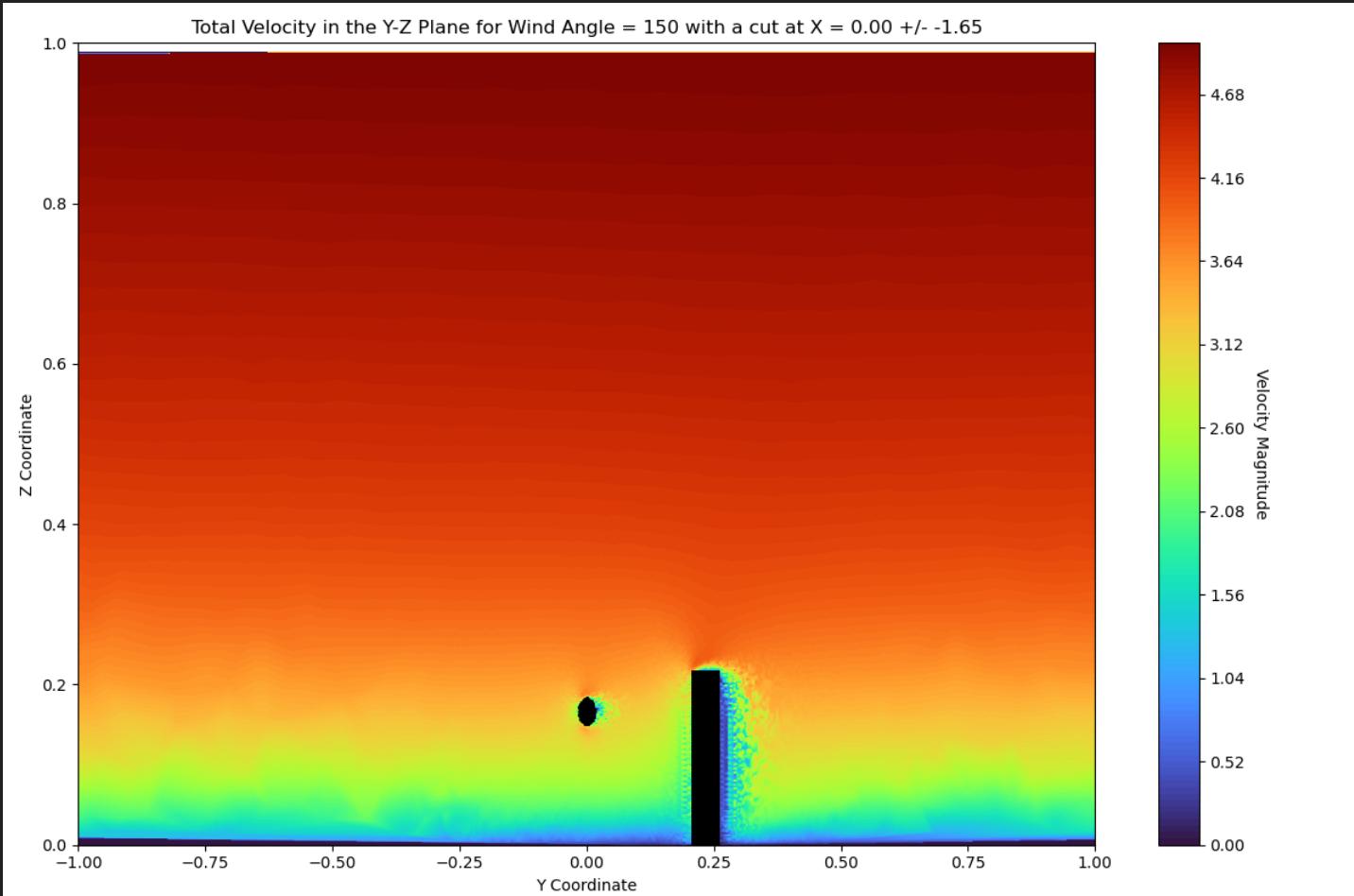
# Data Plots – wind angle = 120



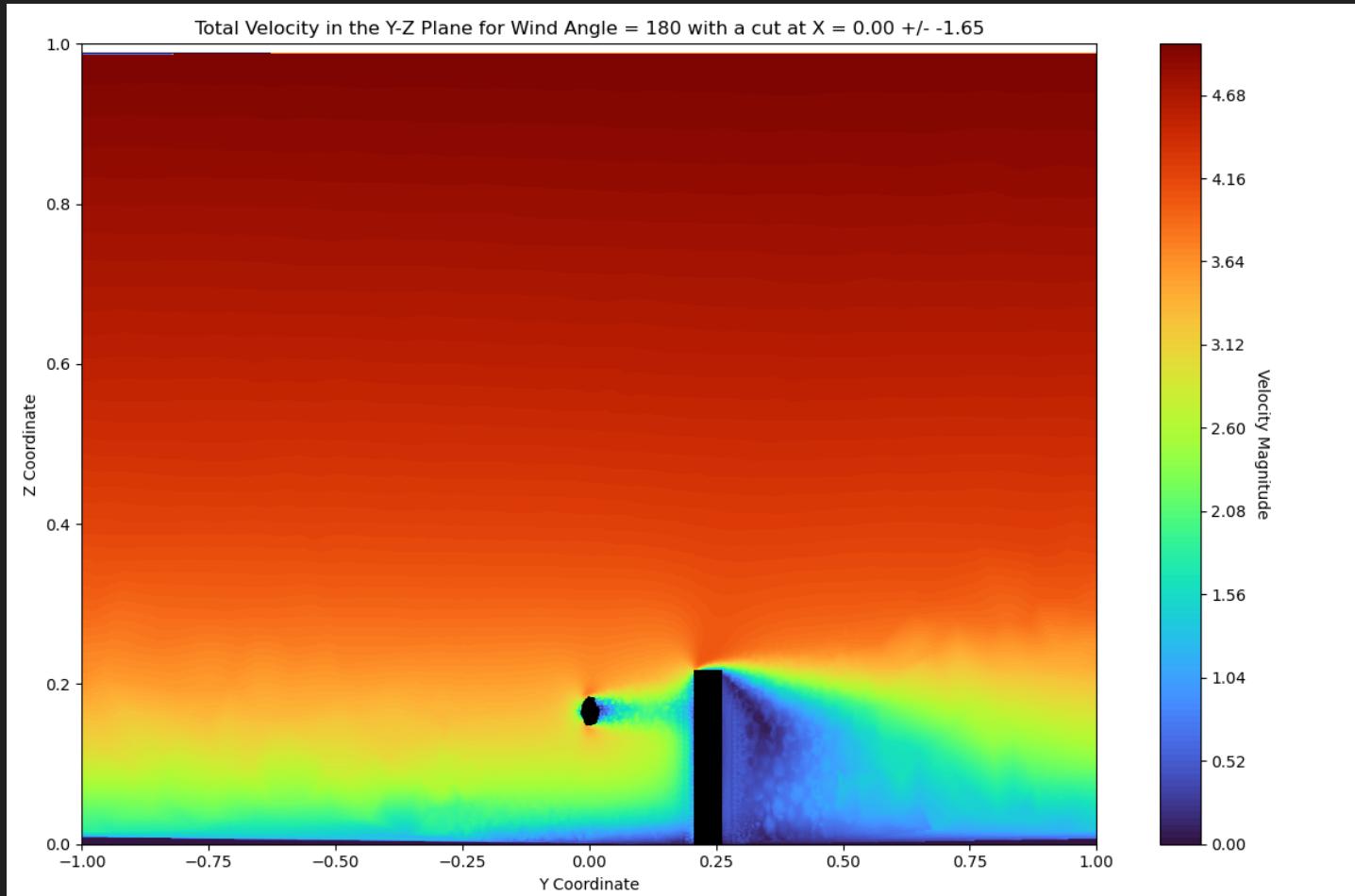
# Data Plots – wind angle = 135



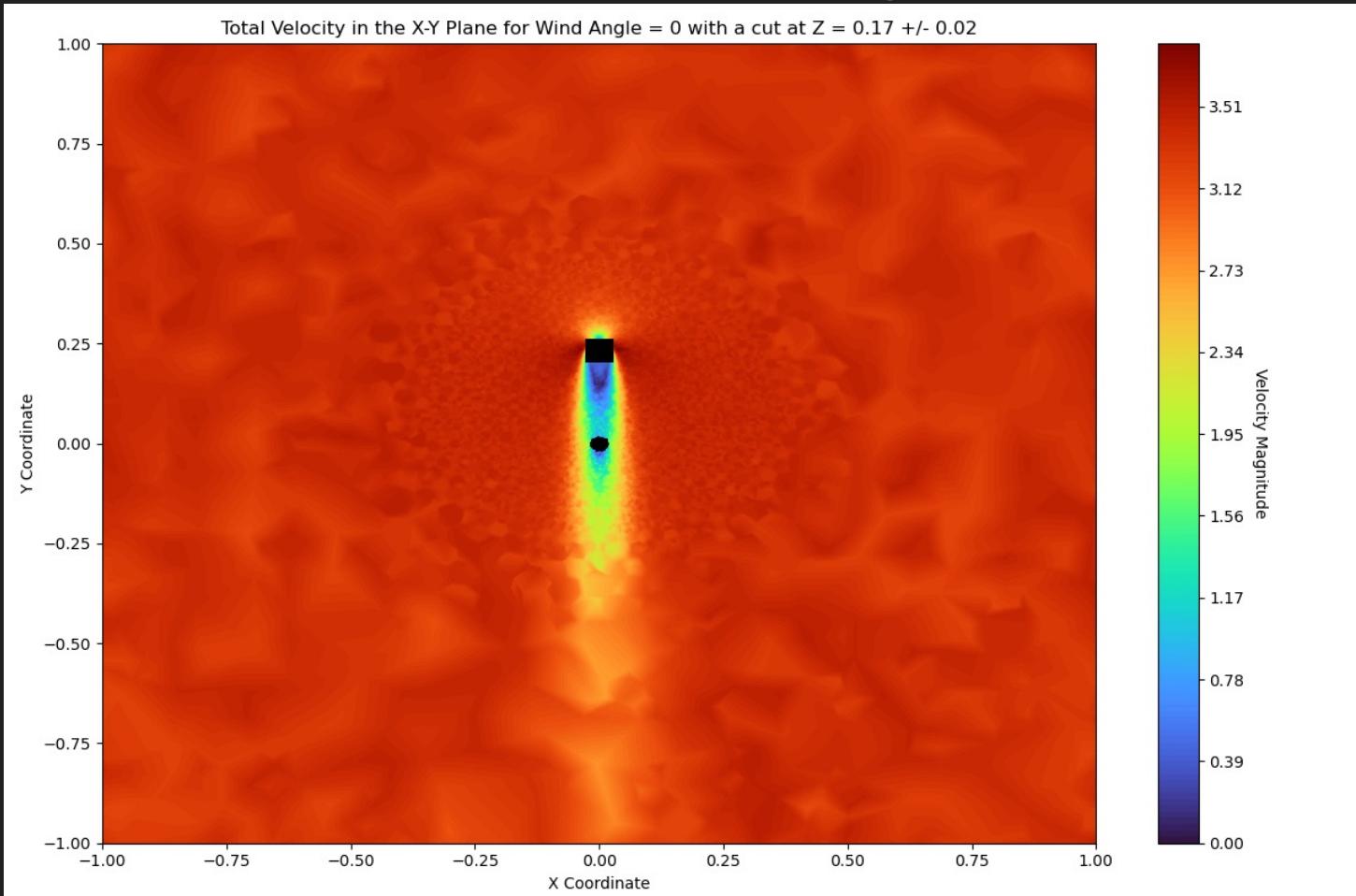
# Data Plots – wind angle = 150



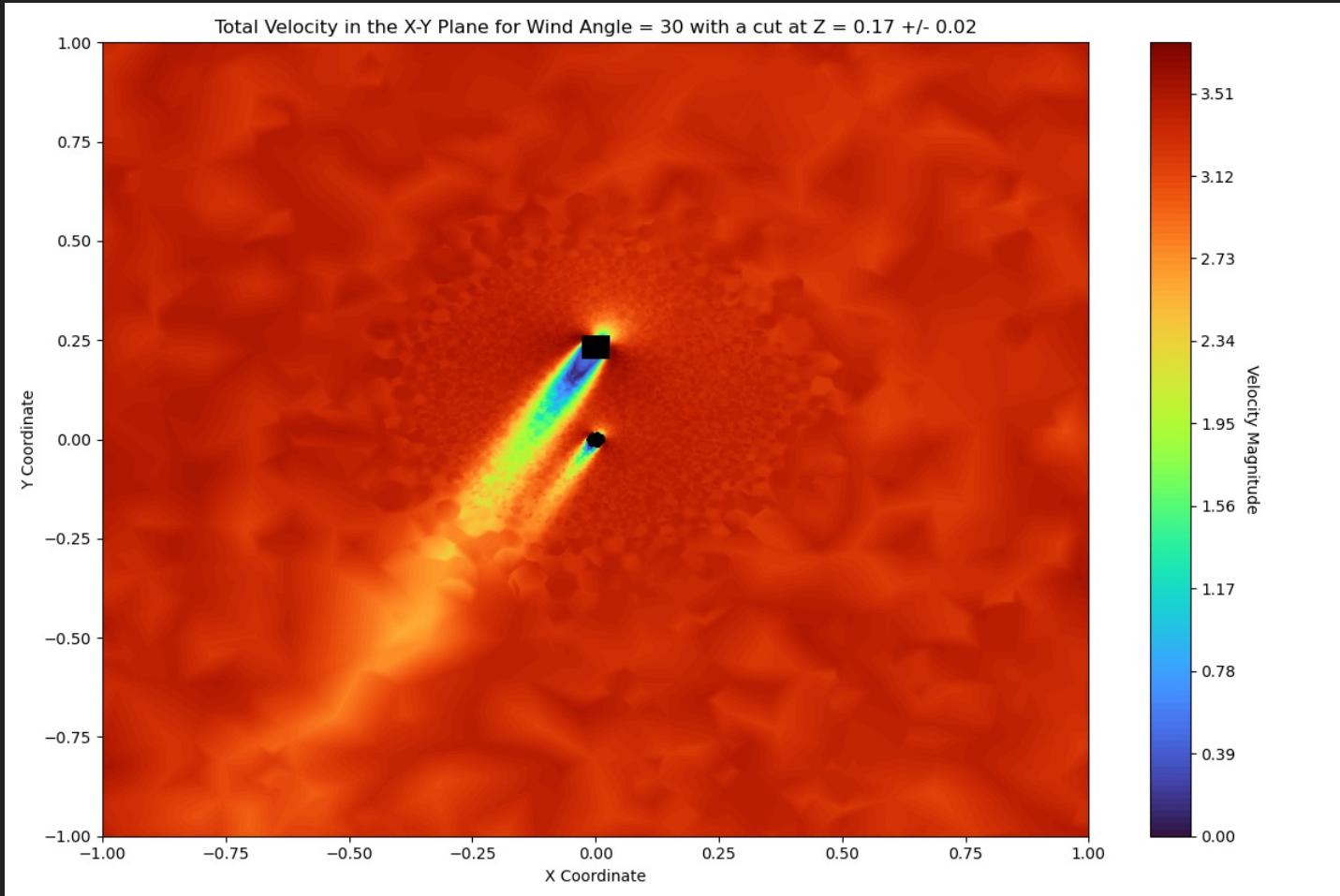
# Data Plots – wind angle = 180



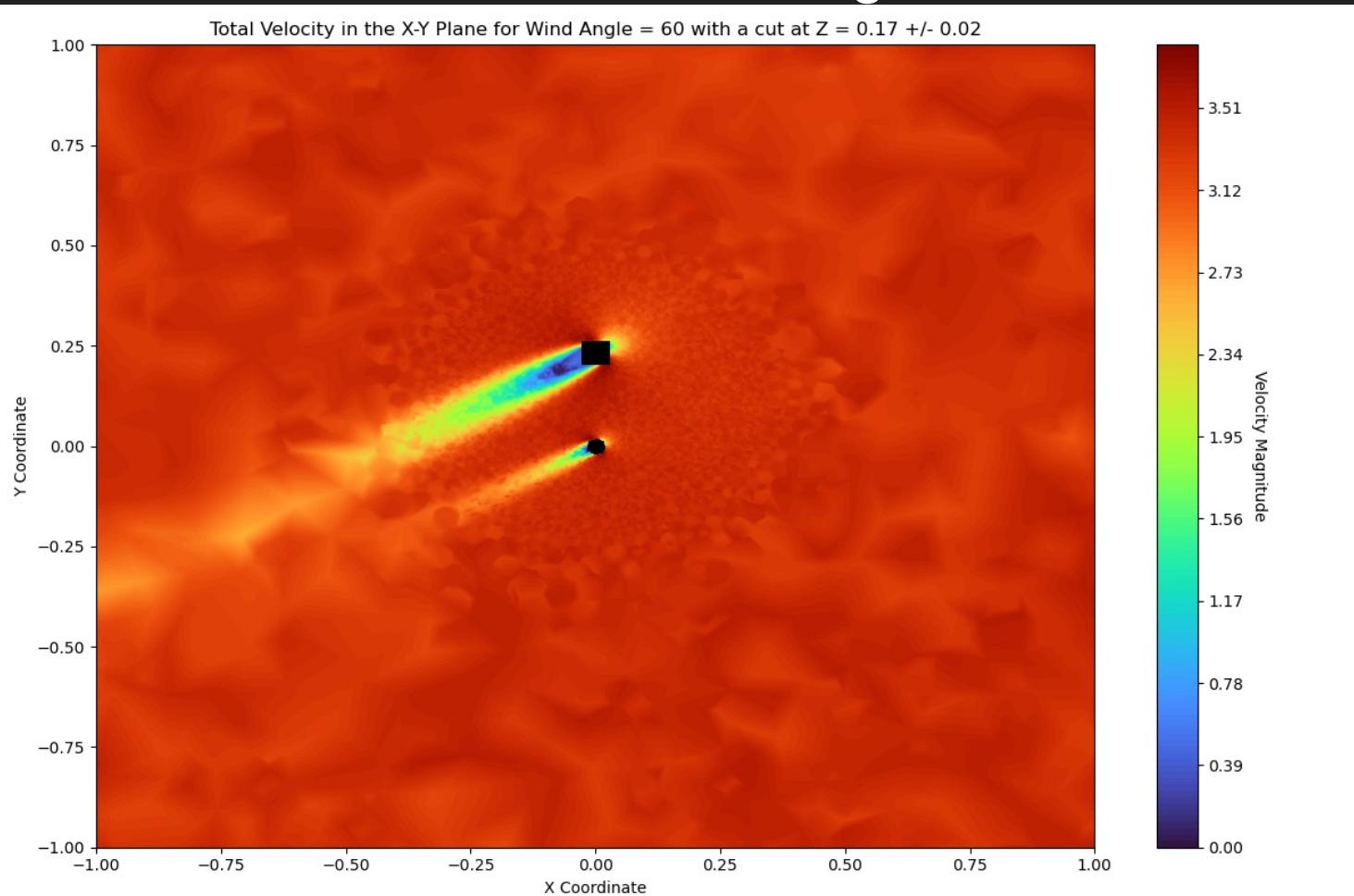
# Data Plots – wind angle = 0



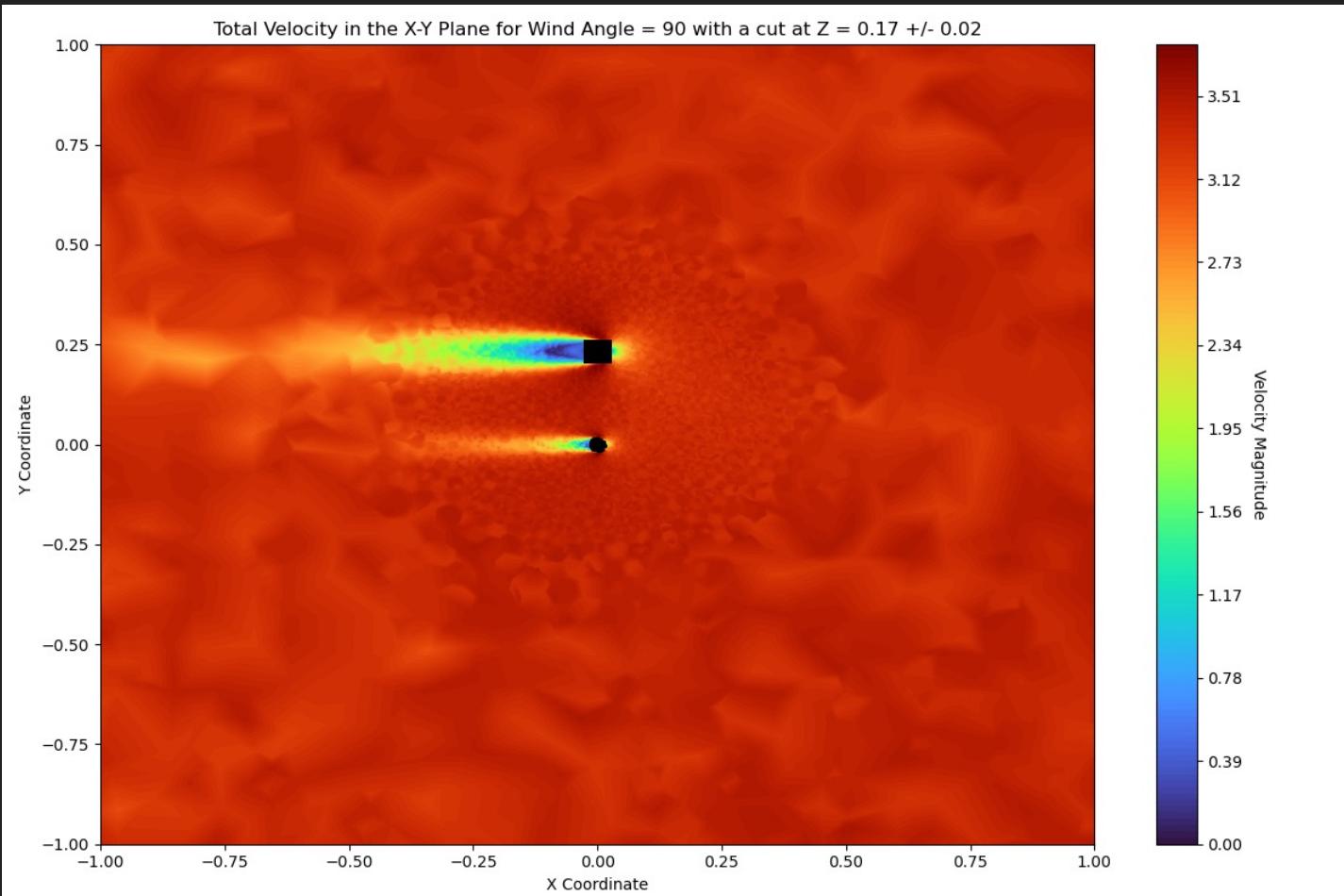
# Data Plots – wind angle = 30



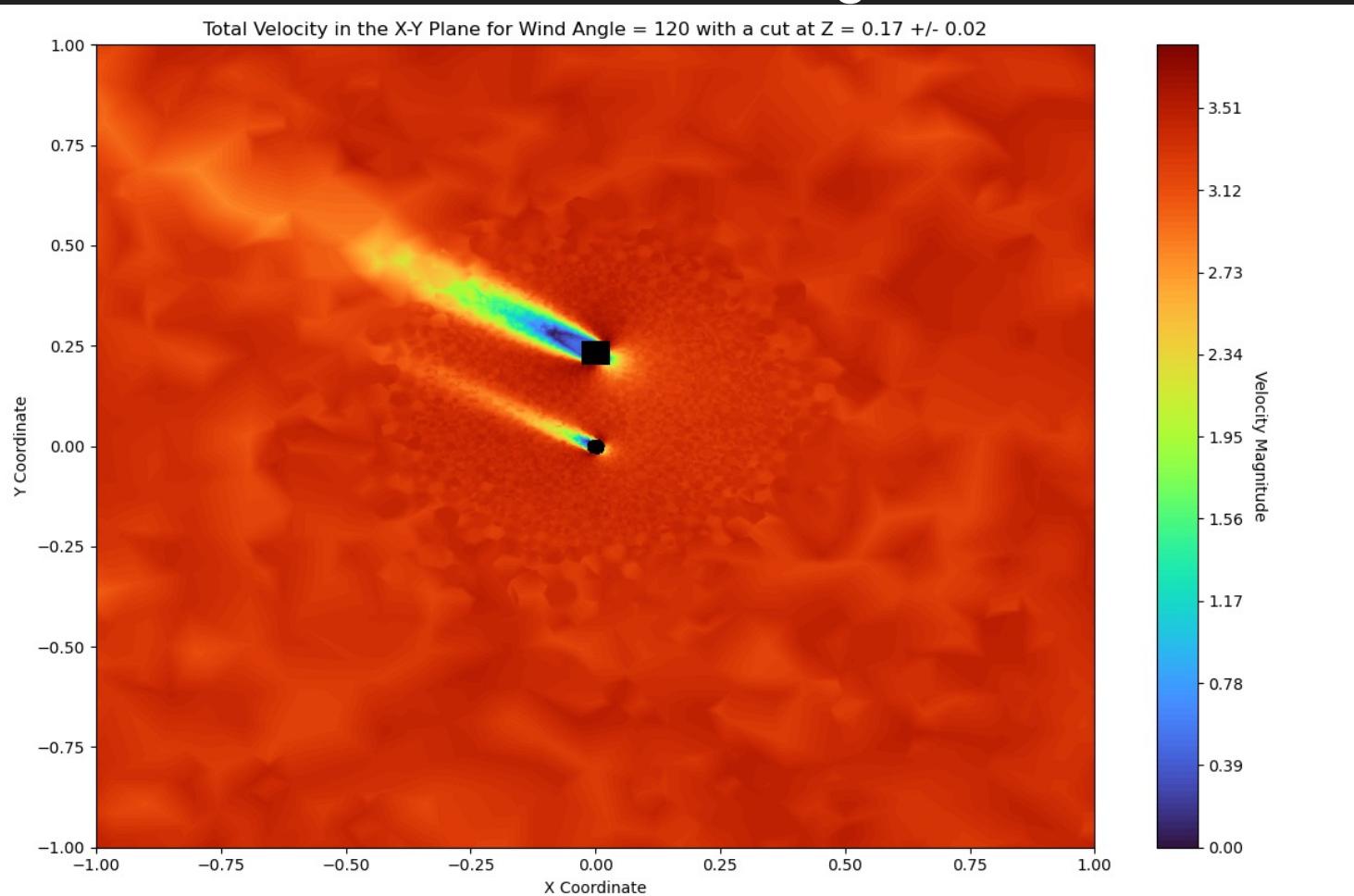
# Data Plots – wind angle = 60



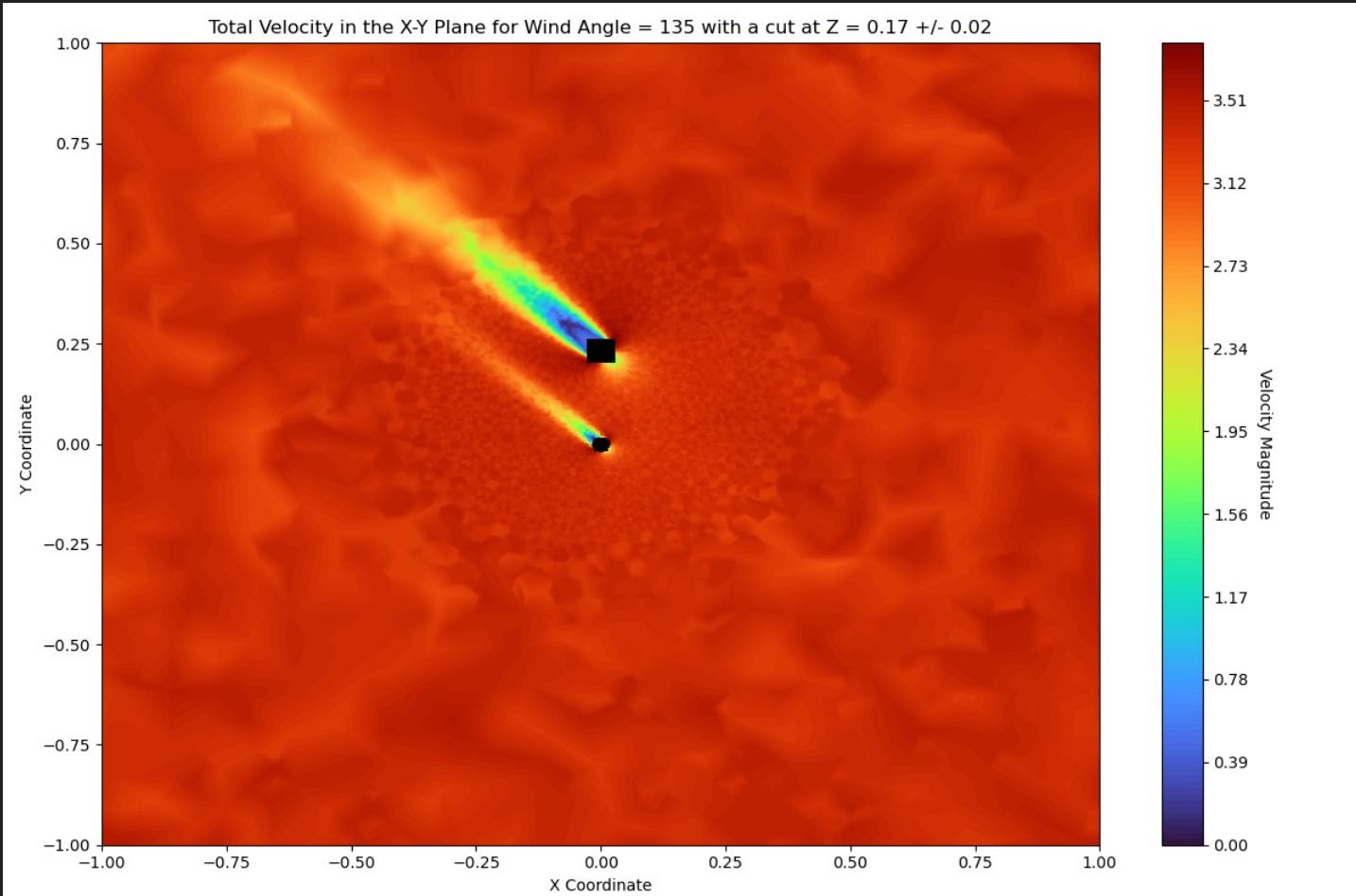
# Data Plots – wind angle = 90



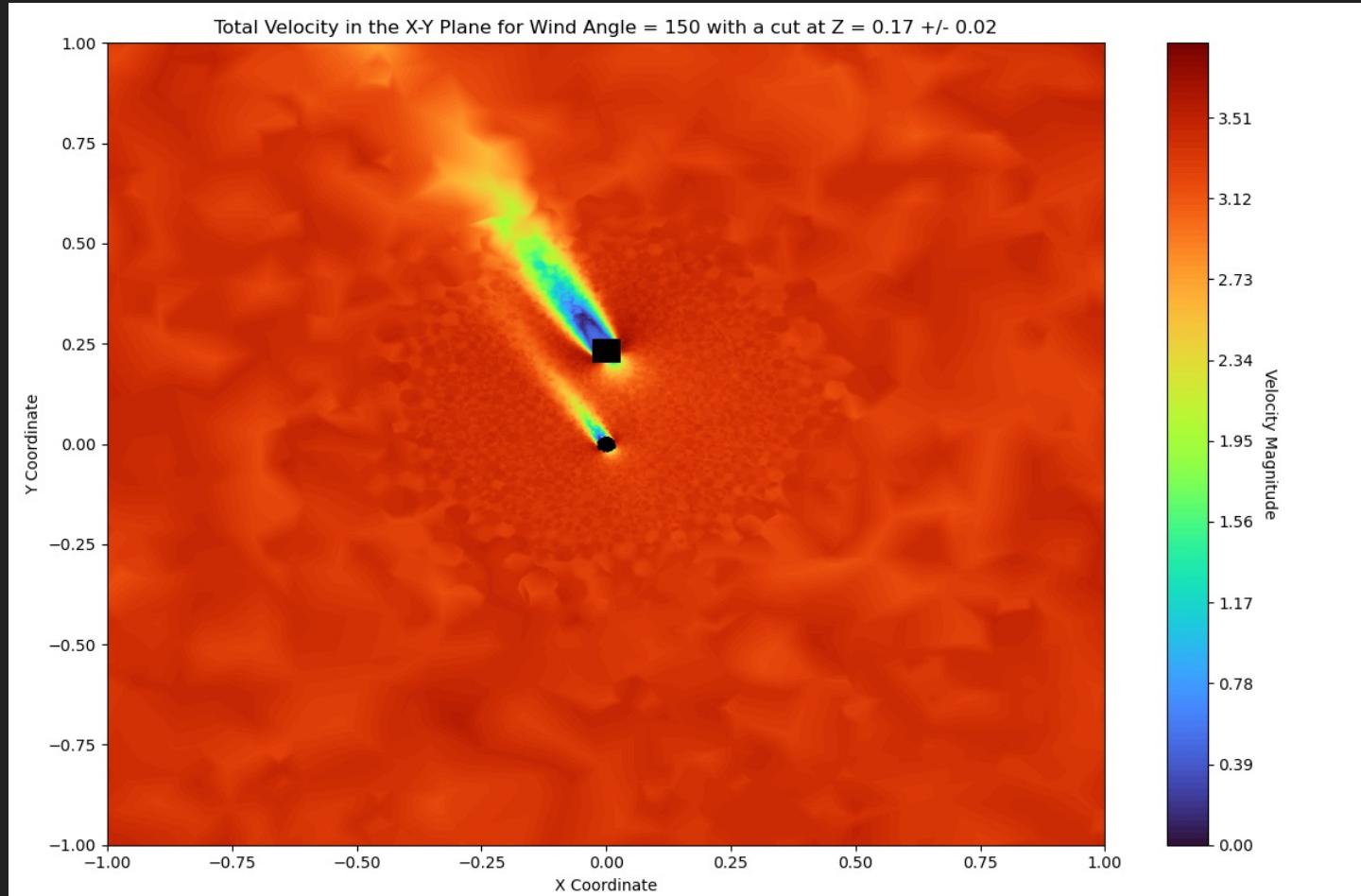
# Data Plots – wind angle = 120



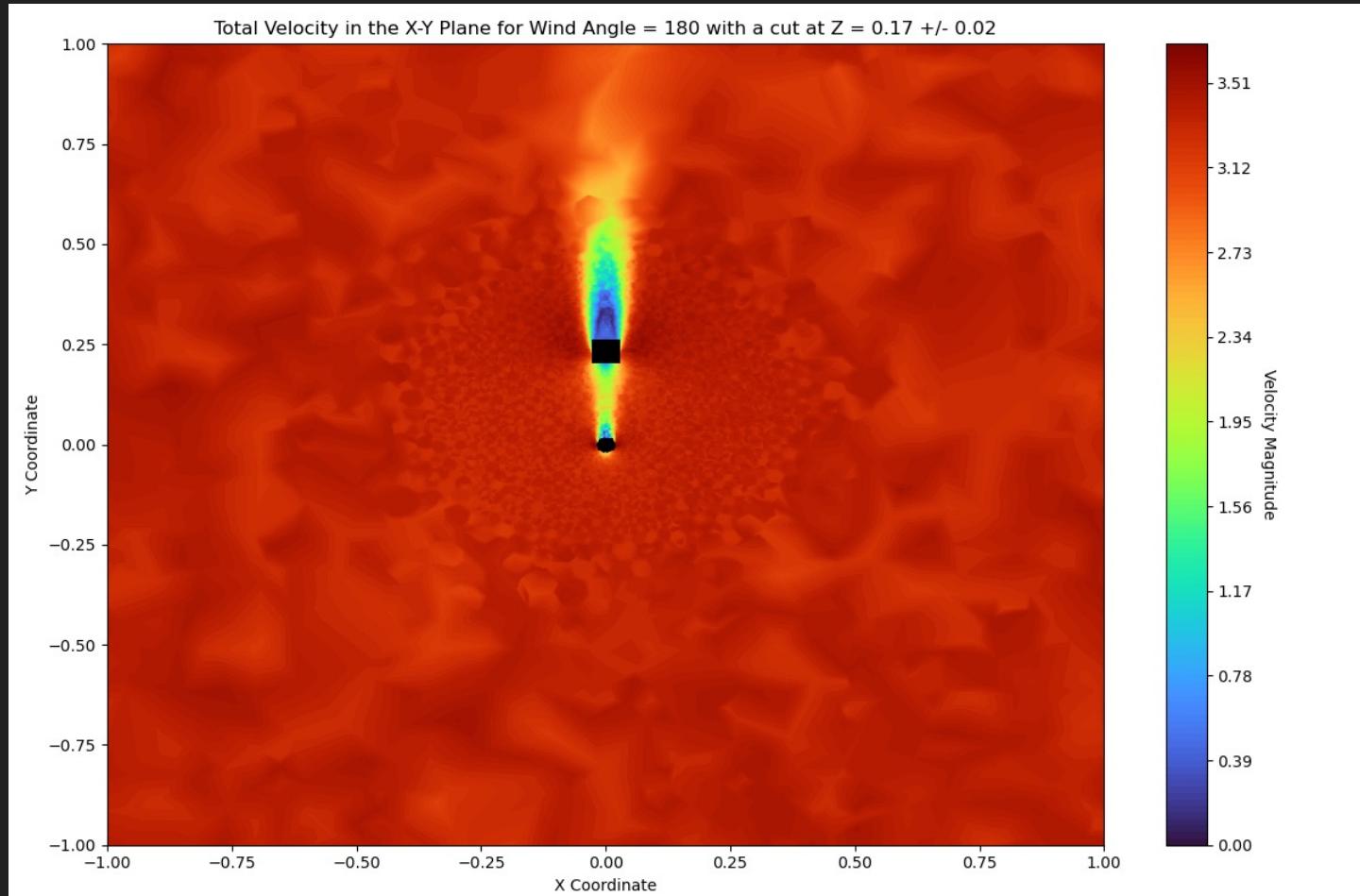
# Data Plots – wind angle = 135



# Data Plots – wind angle = 150



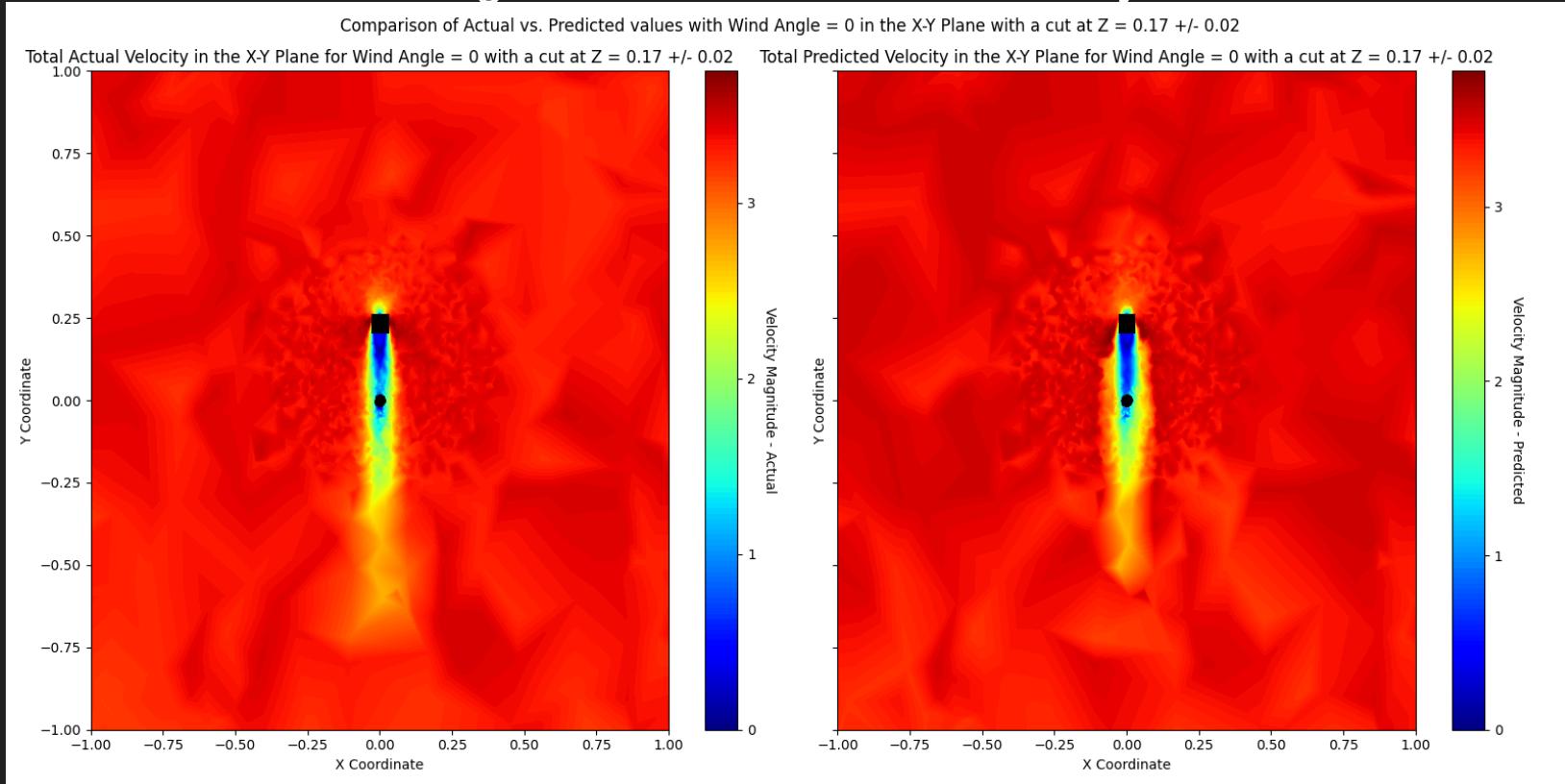
# Data Plots – wind angle = 180



Progress so far - Data Loss + Cont Loss (Adam Optimizer)  
Threshold = 1E-5 (9120 Epochs, so far...), GPU Laptop  
Testing Results - Metrics

Variable	MSE	RMSE	MAE	R2
Pressure	0.03058529	0.1748865	0.08485891	0.99351423
Velocity:0	0.01834383	0.13543941	0.06264316	0.99091249
Velocity:1	0.03576996	0.18912948	0.09784344	0.99567361
Velocity:2	0.00020081	0.0141709	0.00805722	0.99350792

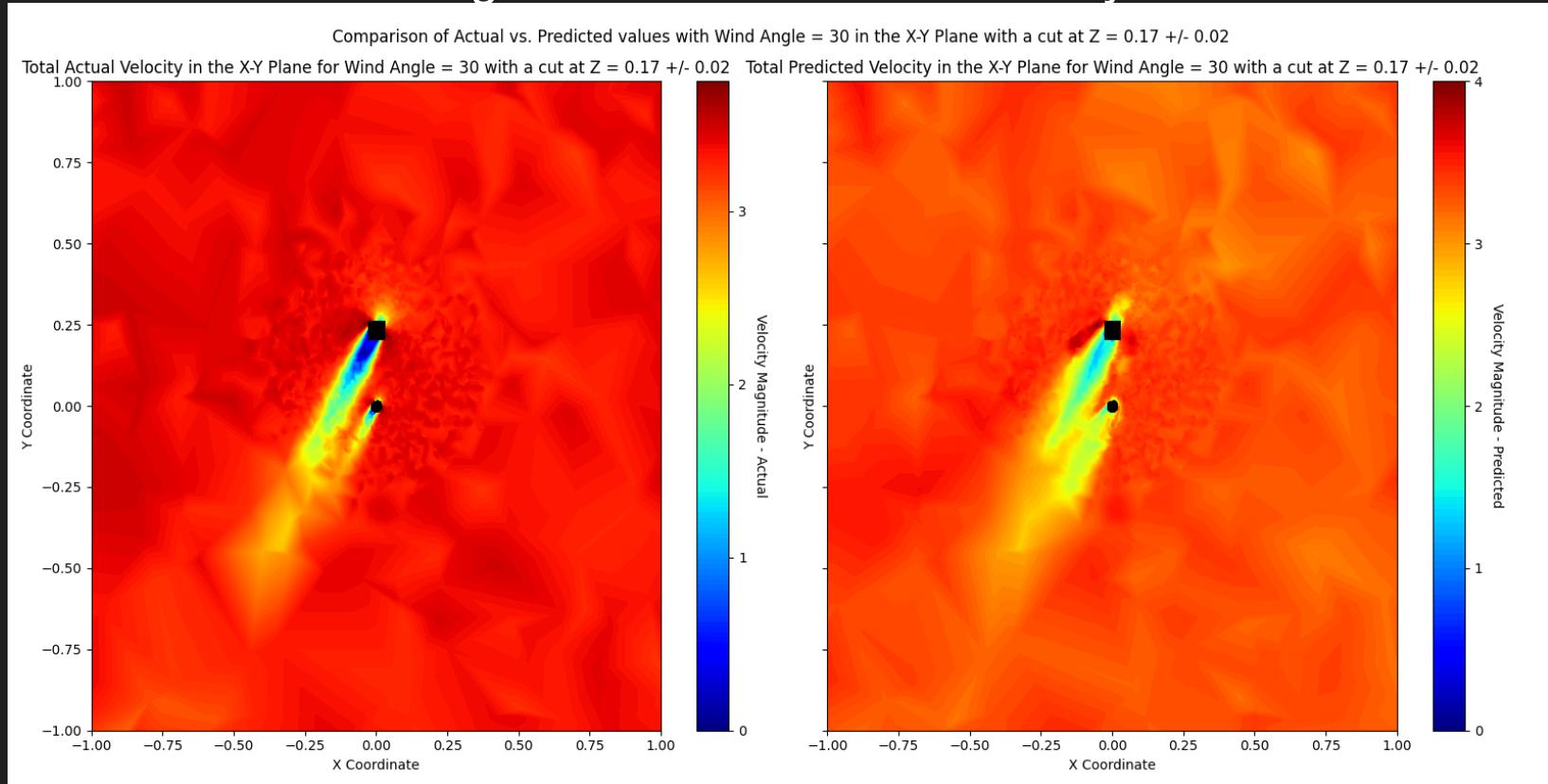
Progress so far - Data Loss + Cont Loss (Adam Optimizer)  
Threshold = 1E-5 (9120 Epochs, so far...), GPU Laptop  
Testing Results - X-Y Total Velocity Plot



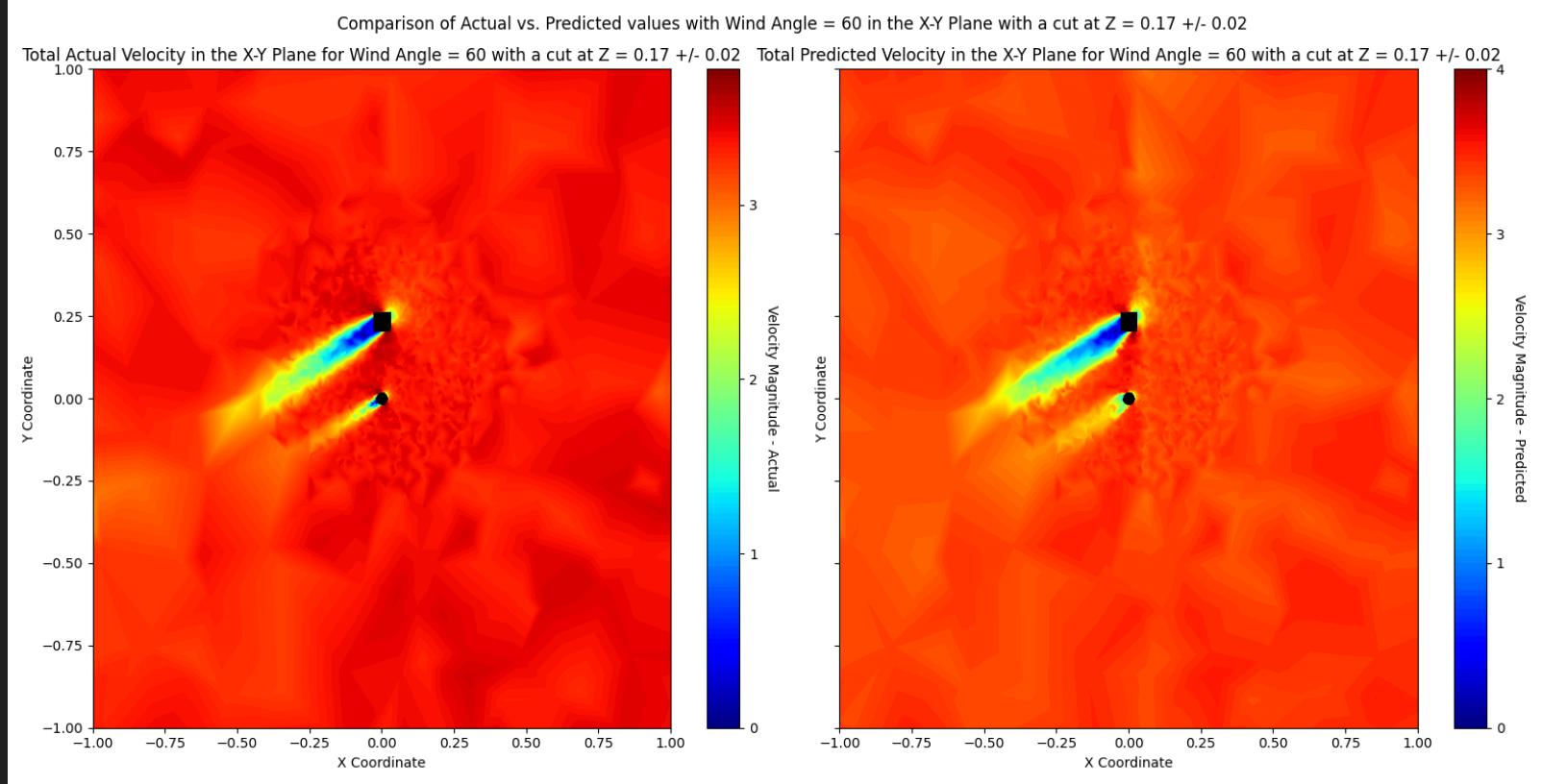
# Progress so far - Data Loss + Cont Loss (Adam Optimizer)

## Threshold = 1E-5 (9120 Epochs, so far...), GPU Laptop

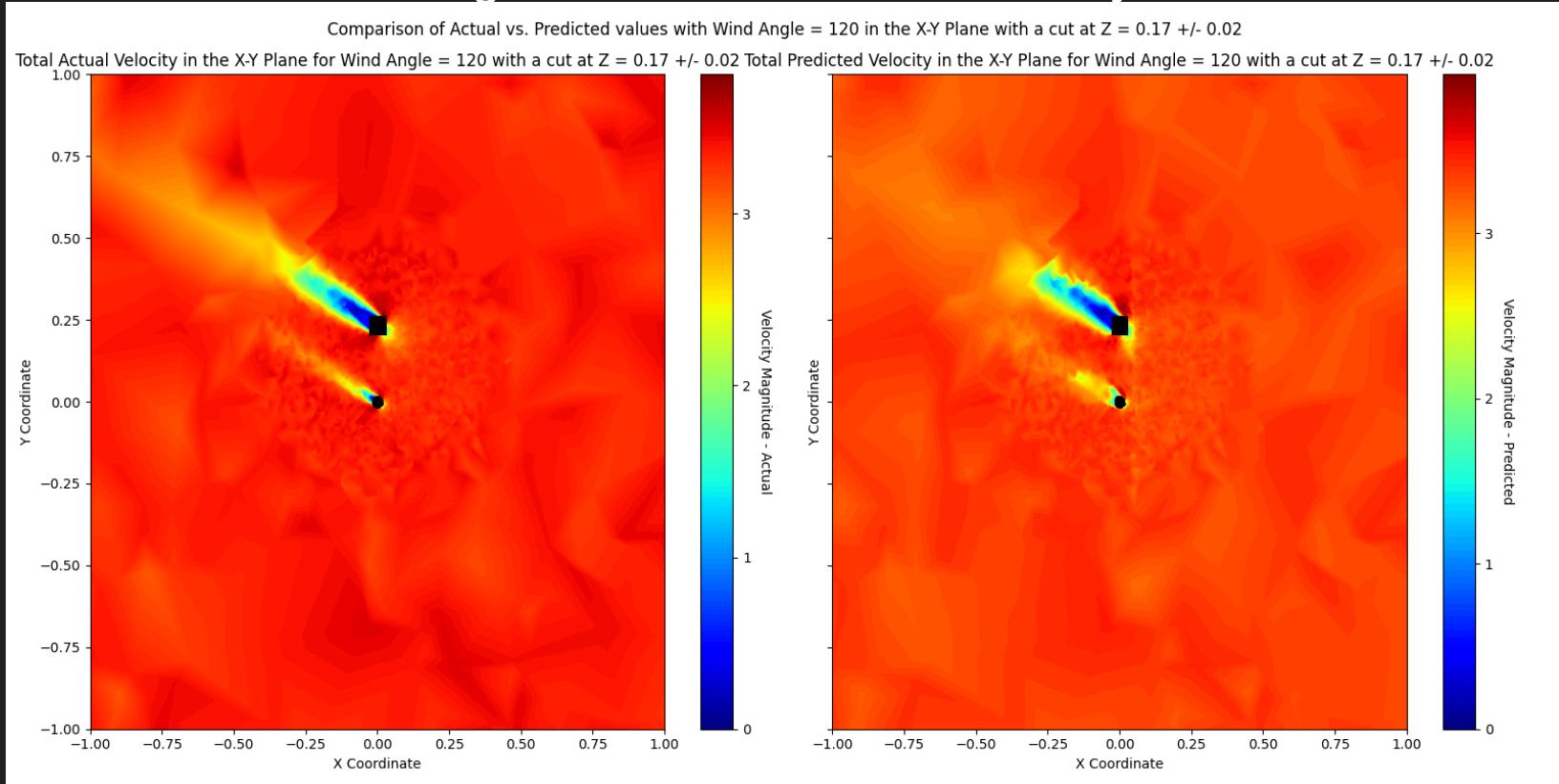
### Testing Results - X-Y Total Velocity Plot



# Progress so far - Data Loss + Cont Loss (Adam Optimizer) Threshold = 1E-5 (9120 Epochs, so far...), GPU Laptop Testing Results - X-Y Total Velocity Plot



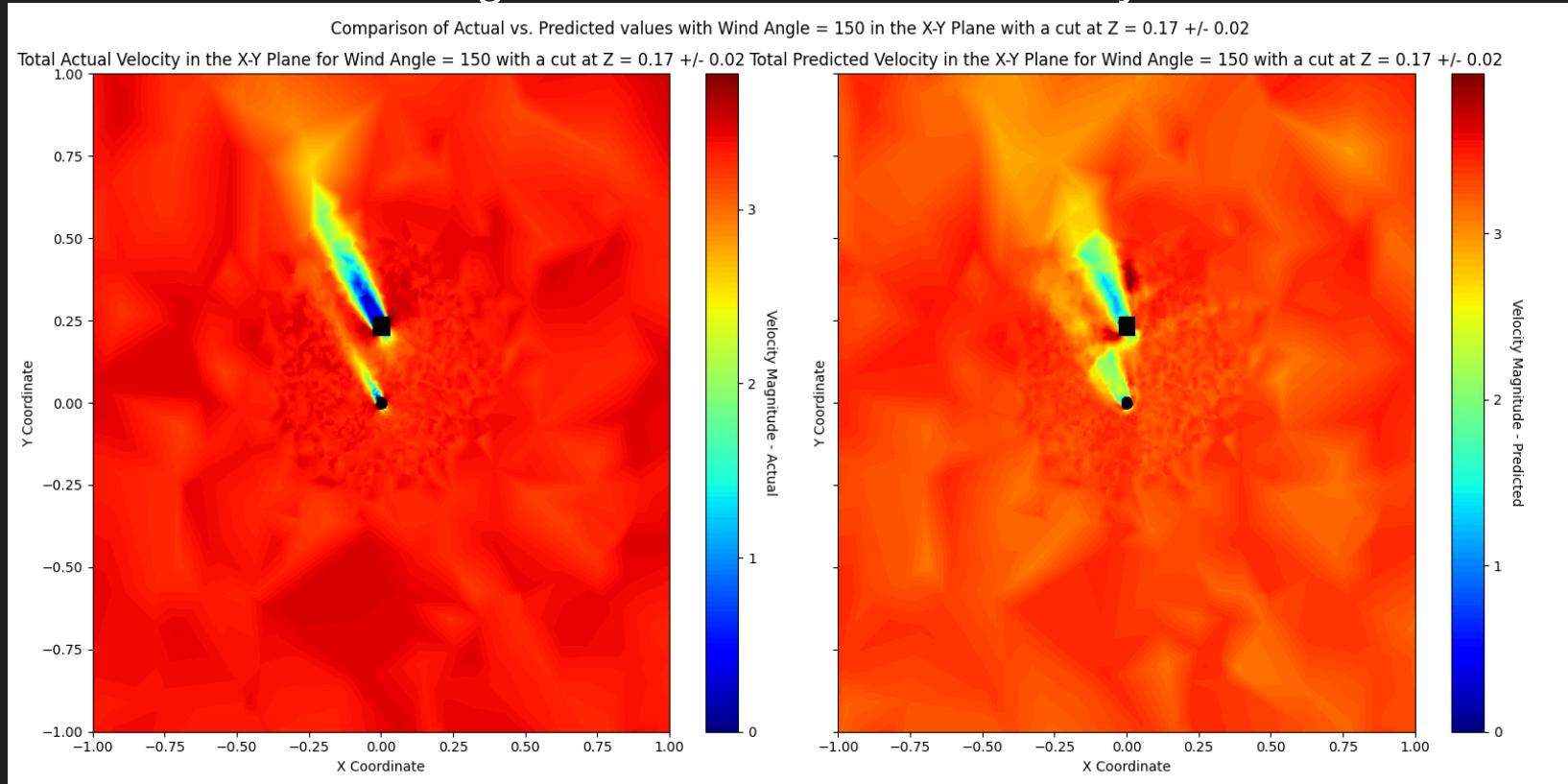
Progress so far - Data Loss + Cont Loss (Adam Optimizer)  
Threshold = 1E-5 (9120 Epochs, so far...), GPU Laptop  
Testing Results - X-Y Total Velocity Plot



# Progress so far - Data Loss + Cont Loss (Adam Optimizer)

## Threshold = 1E-5 (9120 Epochs, so far...), GPU Laptop

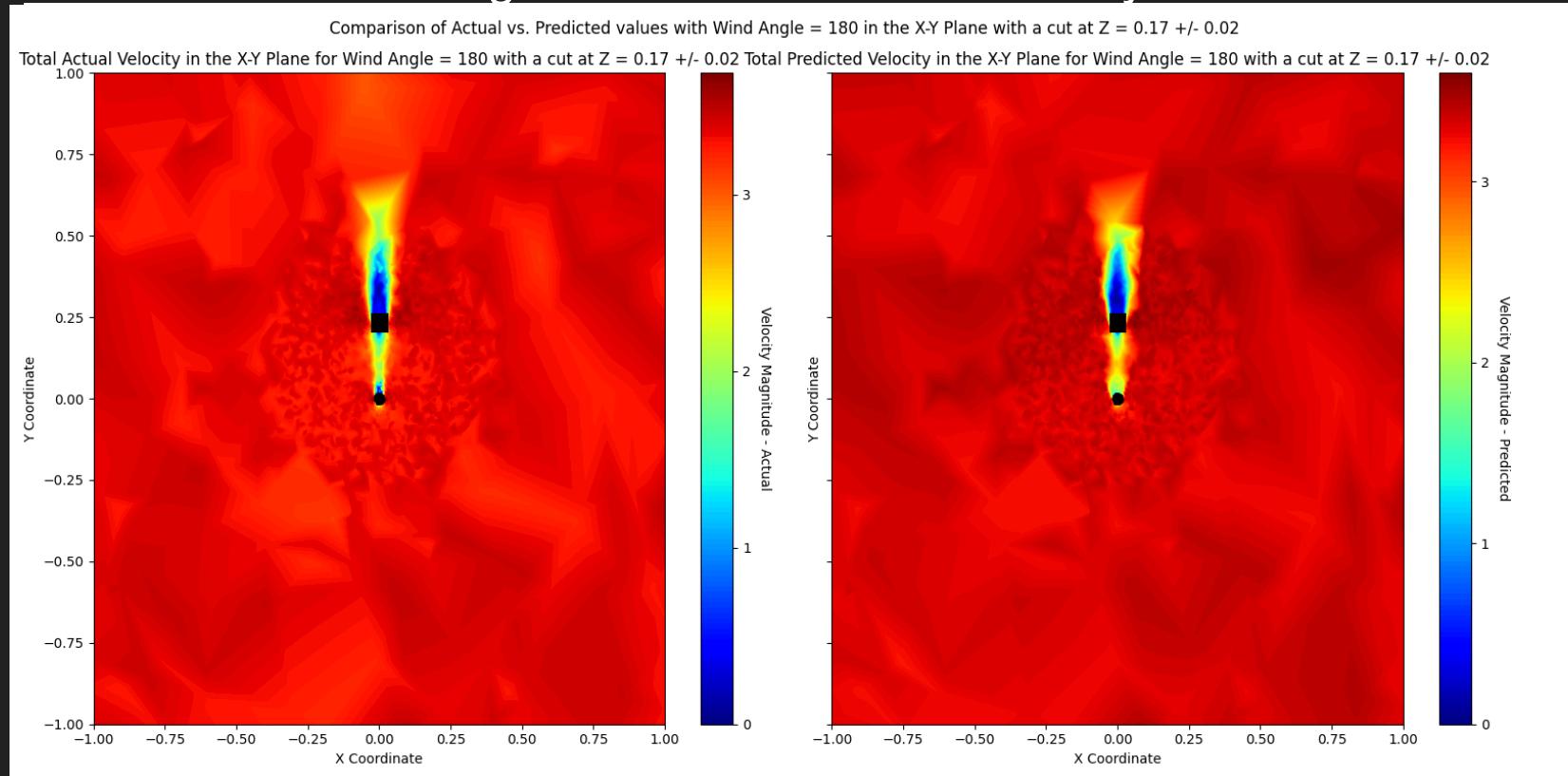
### Testing Results - X-Y Total Velocity Plot



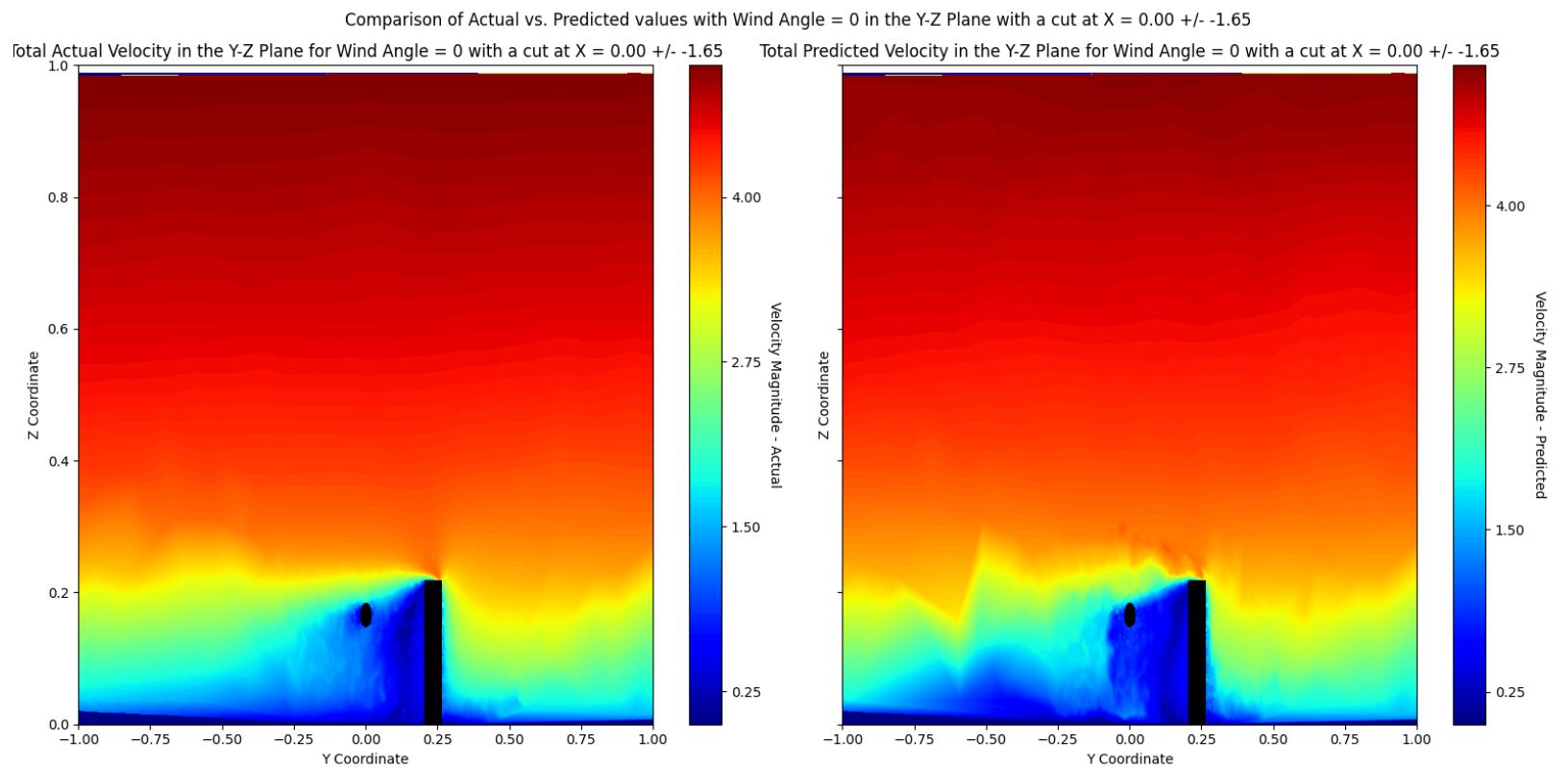
# Progress so far - Data Loss + Cont Loss (Adam Optimizer)

## Threshold = 1E-5 (9120 Epochs, so far...), GPU Laptop

### Testing Results - X-Y Total Velocity Plot



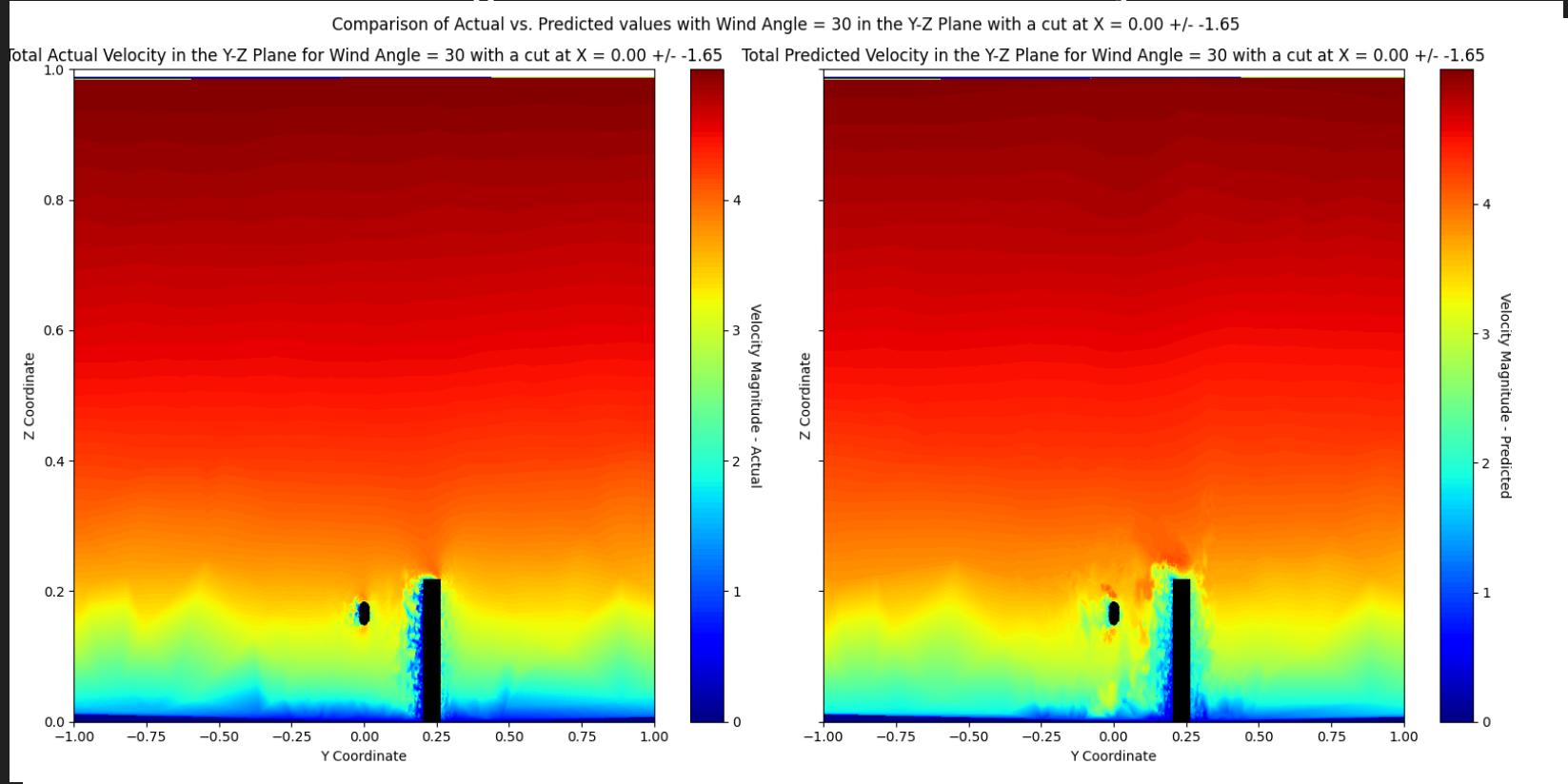
Progress so far - Data Loss + Cont Loss (Adam Optimizer)  
Threshold = 1E-5 (9120 Epochs, so far...), GPU Laptop  
Testing Results – Y-Z Total Velocity Plot



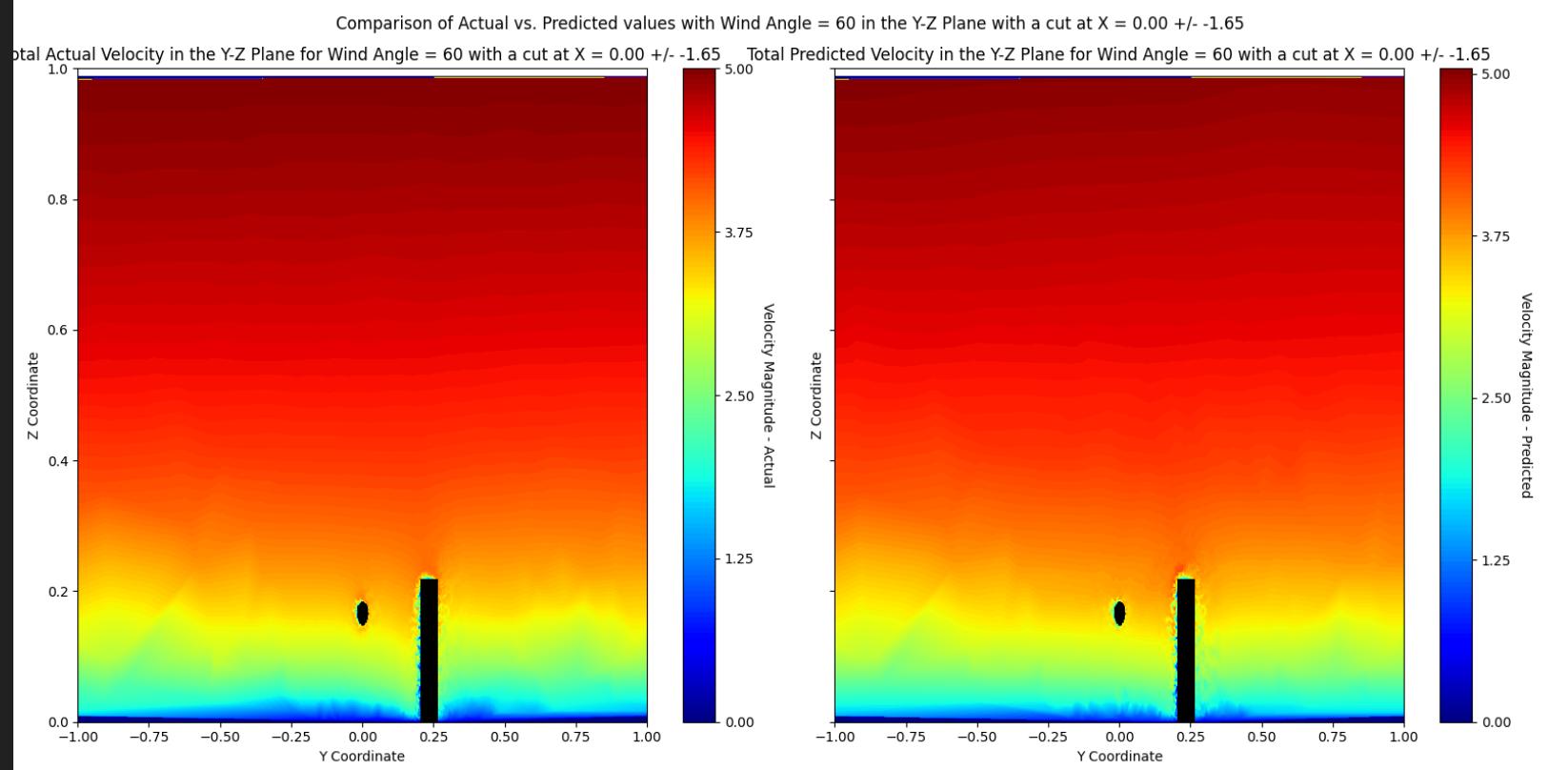
# Progress so far - Data Loss + Cont Loss (Adam Optimizer)

## Threshold = 1E-5 (9120 Epochs, so far...), GPU Laptop

### Testing Results – Y-Z Total Velocity Plot



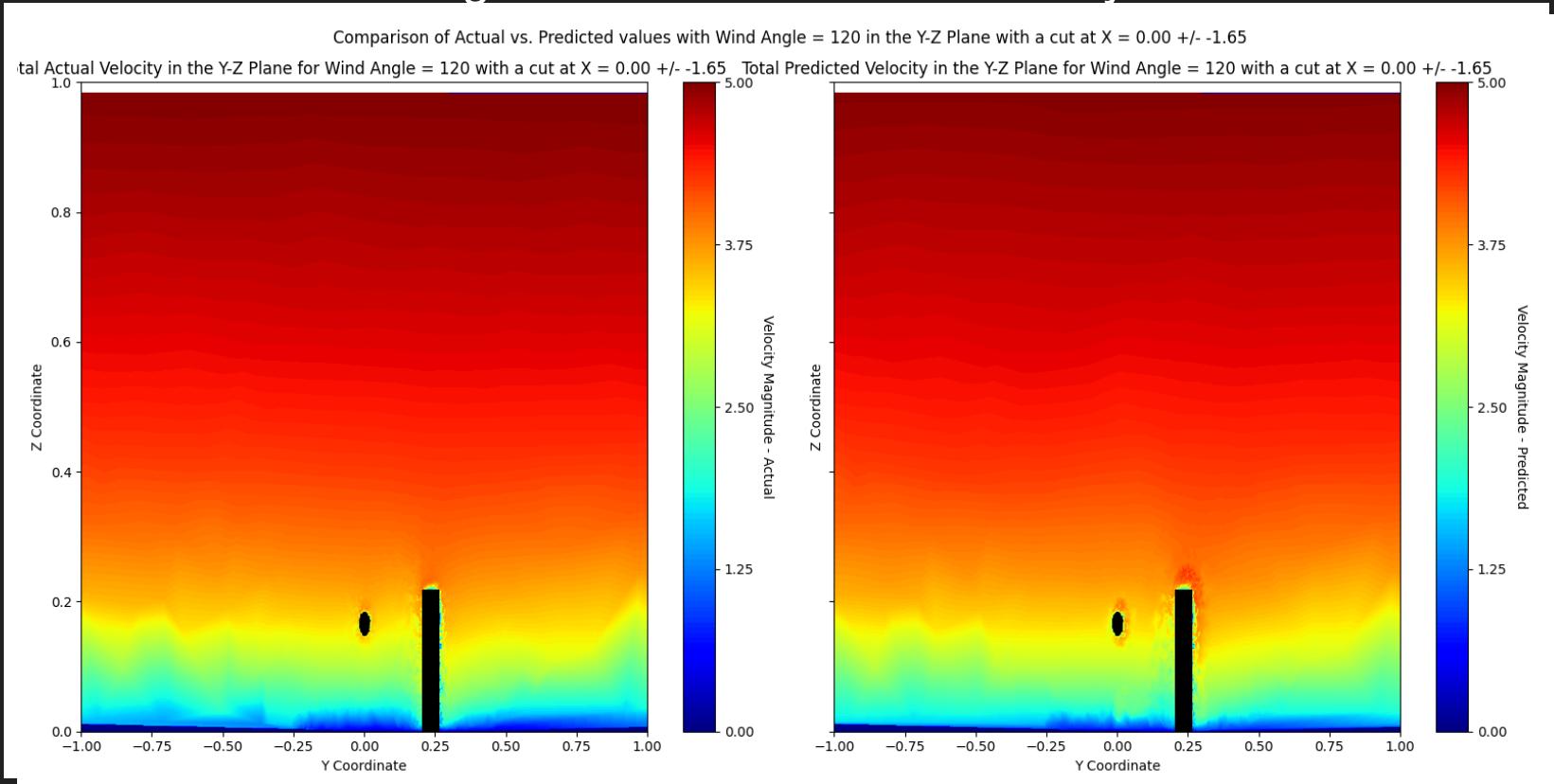
Progress so far - Data Loss + Cont Loss (Adam Optimizer)  
Threshold = 1E-5 (9120 Epochs, so far...), GPU Laptop  
Testing Results – Y-Z Total Velocity Plot



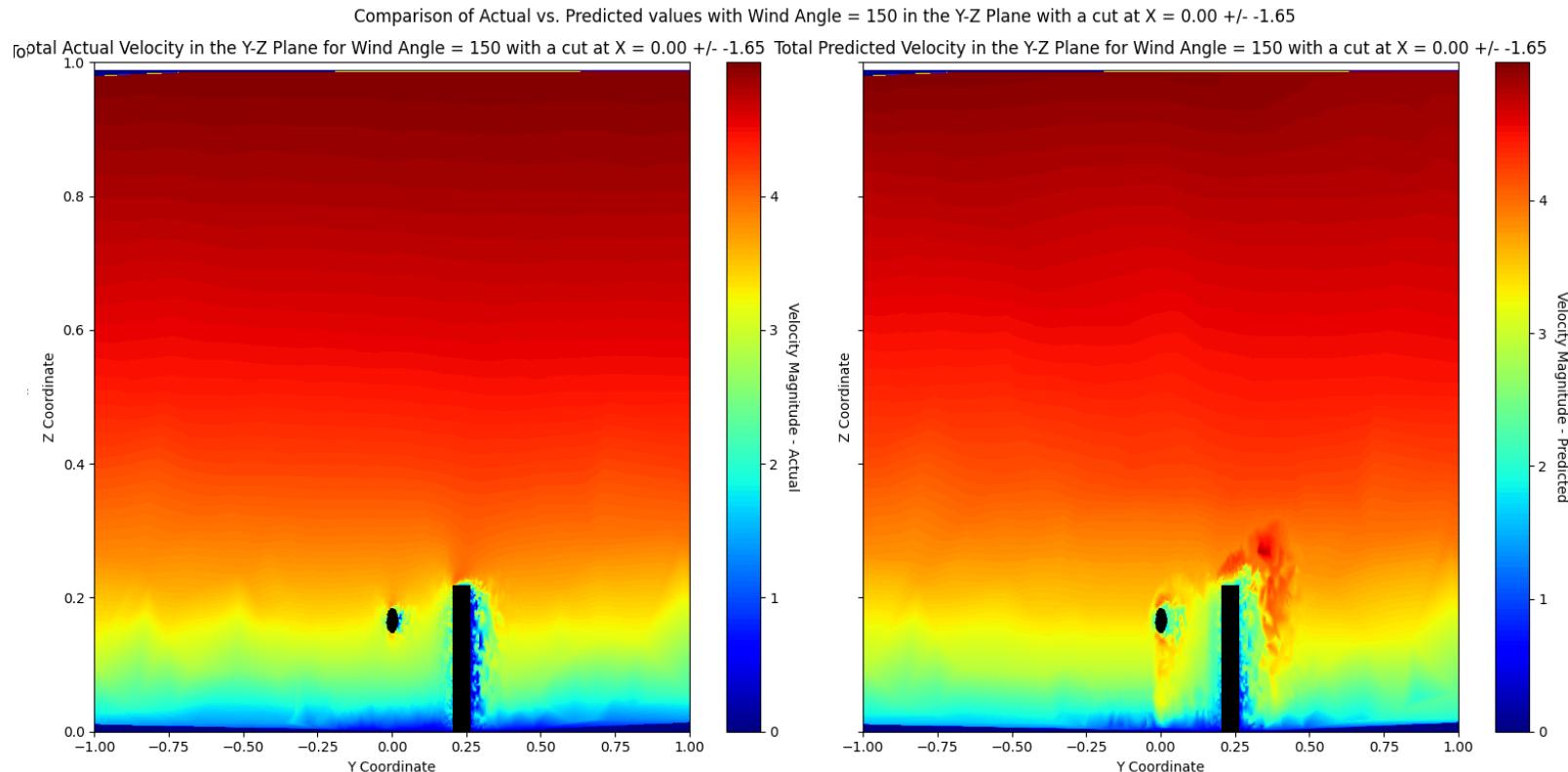
# Progress so far - Data Loss + Cont Loss (Adam Optimizer)

## Threshold = 1E-5 (9120 Epochs, so far...), GPU Laptop

### Testing Results – Y-Z Total Velocity Plot



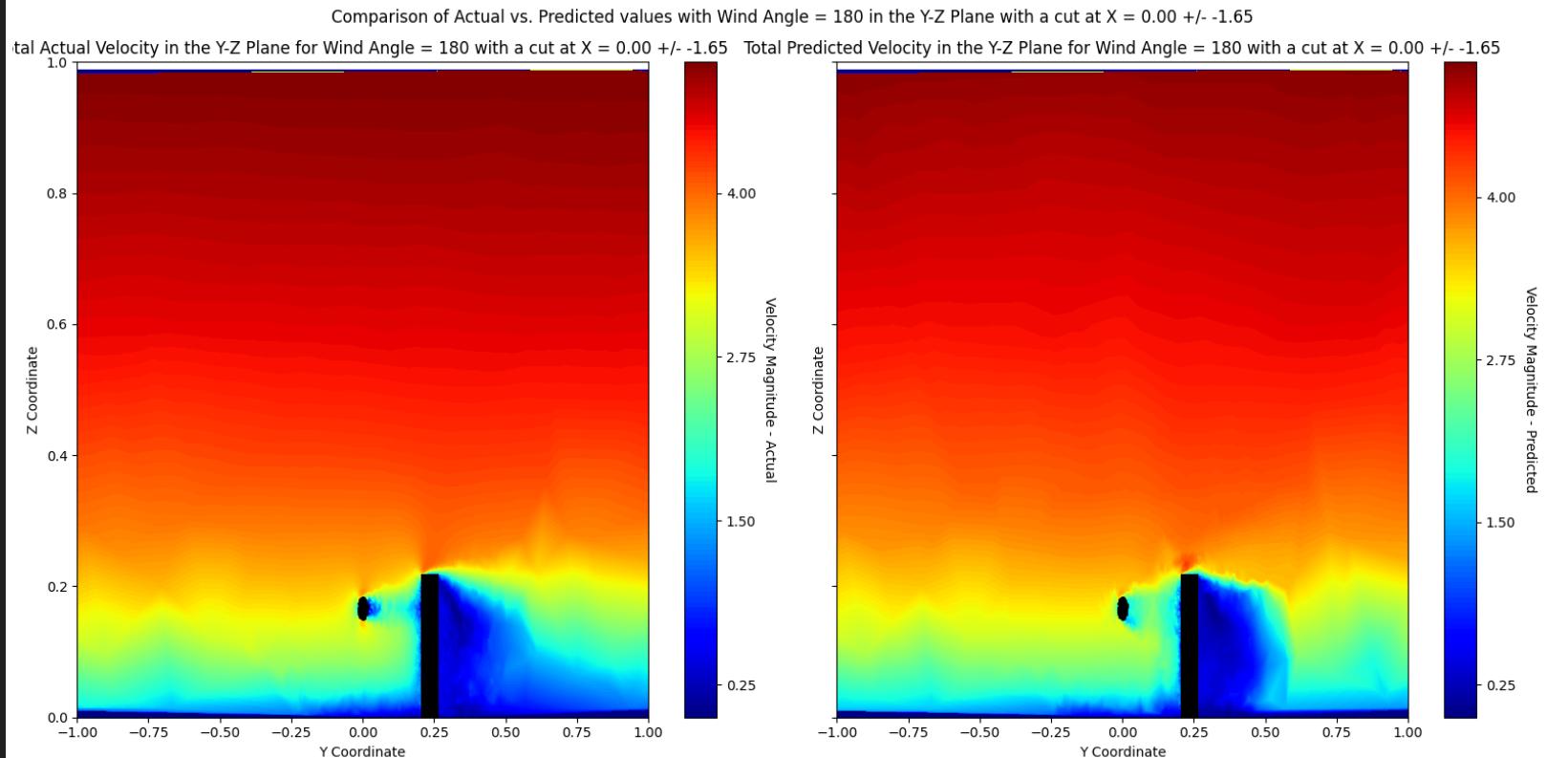
Progress so far - Data Loss + Cont Loss (Adam Optimizer)  
Threshold = 1E-5 (9120 Epochs, so far...), GPU Laptop  
Testing Results – Y-Z Total Velocity Plot



# Progress so far - Data Loss + Cont Loss (Adam Optimizer)

## Threshold = 1E-5 (9120 Epochs, so far...), GPU Laptop

### Testing Results – Y-Z Total Velocity Plot



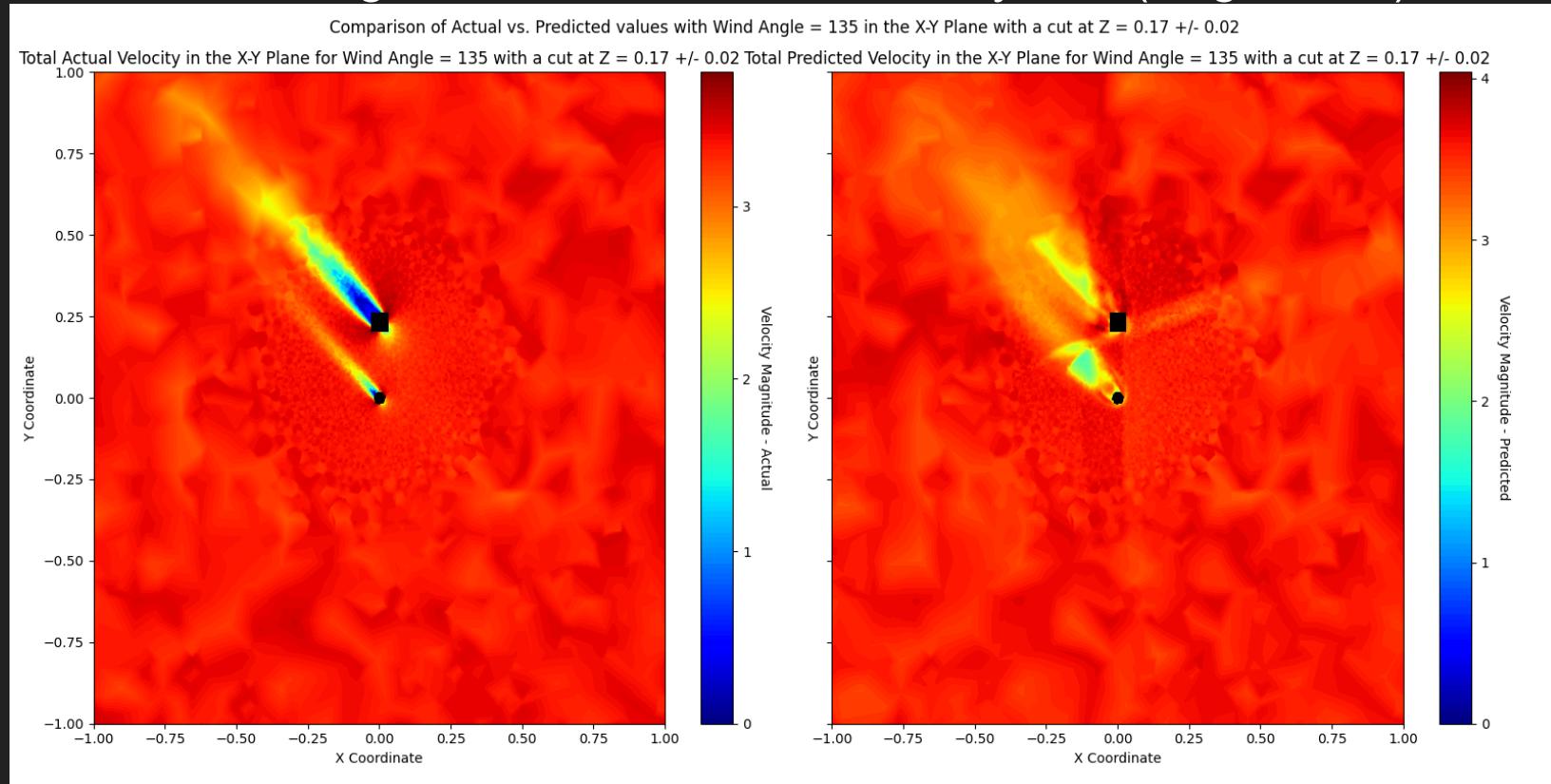
Progress so far - Data Loss + Cont Loss (Adam Optimizer)  
Threshold = 1E-5 (9120 Epochs, so far...), GPU Laptop  
Predicting Results – Metrics (Angle = 90)

Variable	MSE	RMSE	MAE	R2
Pressure	2.2540561	1.50135142	0.86987386	-0.2948265
Velocity:0	1.74568219	1.32124267	0.75204798	0.12026278
Velocity:1	4.33544267	2.08217258	1.99781828	-83.253256
Velocity:2	0.05317863	0.23060492	0.11664684	-0.6053989

# Progress so far - Data Loss + Cont Loss (Adam Optimizer)

## Threshold = 1E-5 (7680 Epochs, so far...), GPU Laptop

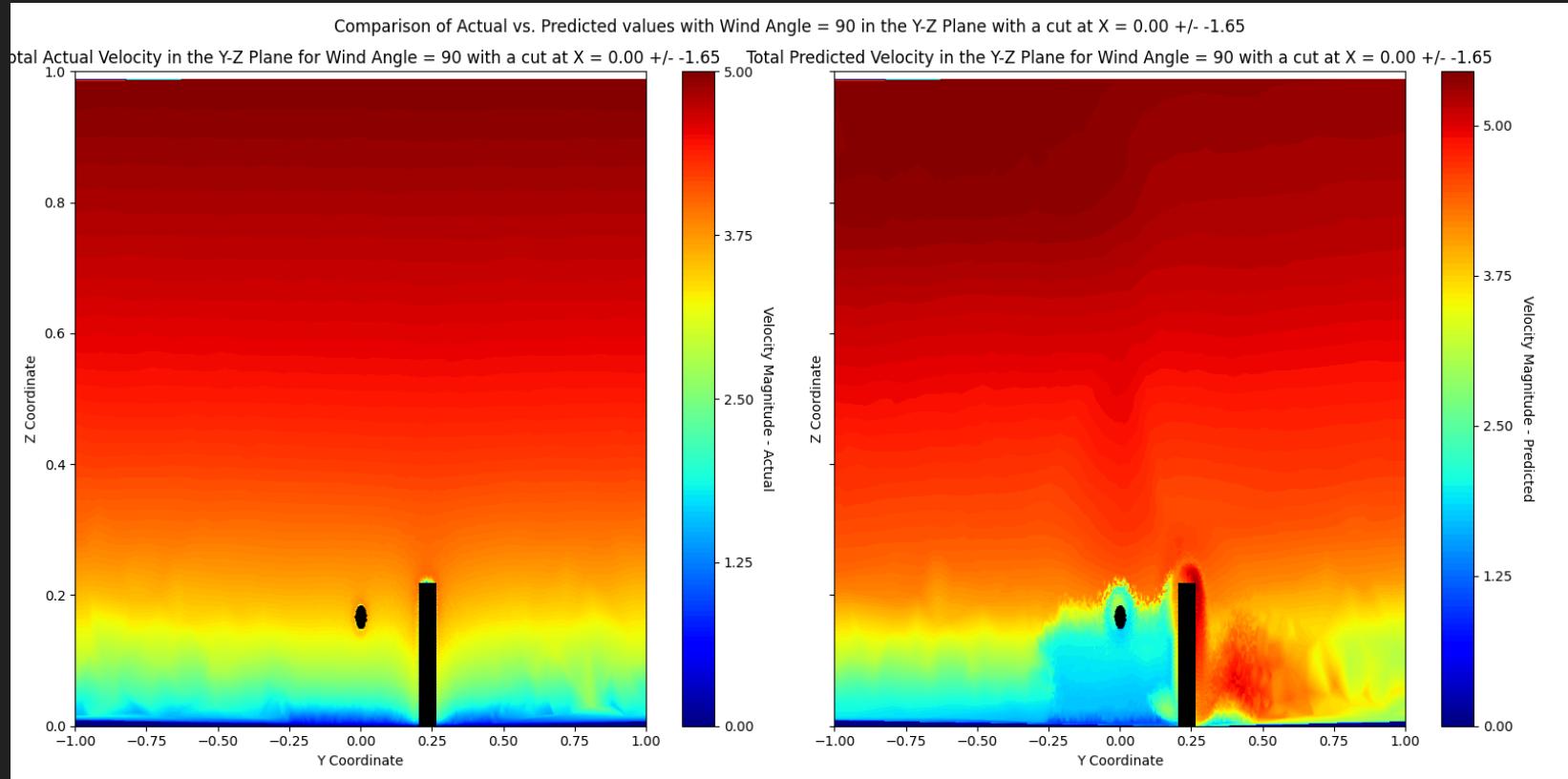
### Predicting Results - X-Y Total Velocity Plot (Angle = 90)



# Progress so far - Data Loss + Cont Loss (Adam Optimizer)

## Threshold = 1E-5 (7680 Epochs, so far...), GPU Laptop

### Predicting Results - Y-Z Total Velocity Plot (Angle = 90)



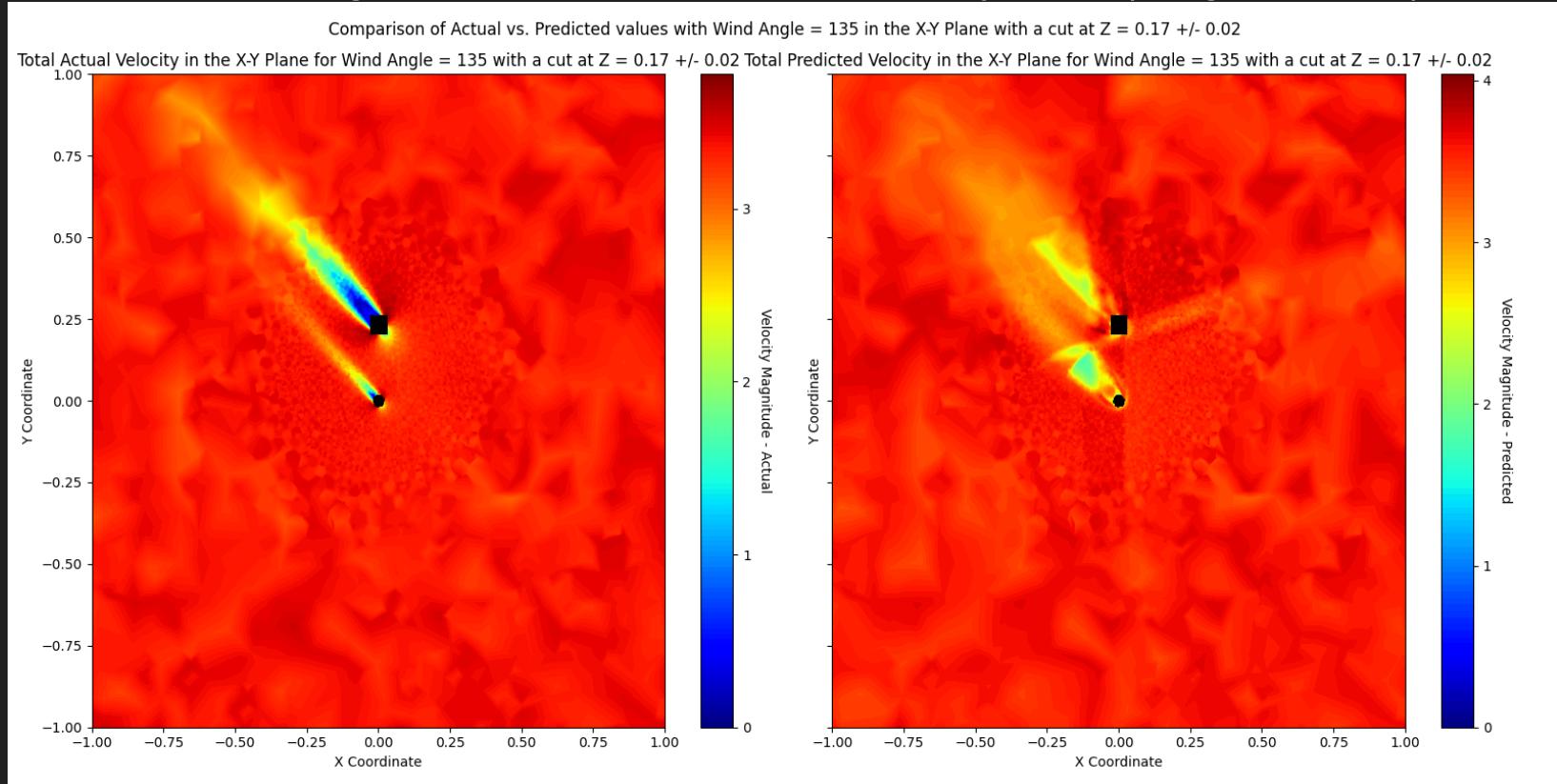
Progress so far - Data Loss + Cont Loss (Adam Optimizer)  
Threshold = 1E-5 (9120 Epochs, so far...), GPU Laptop  
Predicting Results – Metrics (Angle = 135)

Variable	MSE	RMSE	MAE	R2
Pressure	1.48405698	1.21821877	0.68451799	0.12204593
Velocity:0	0.29097088	0.53941716	0.24768495	0.71451734
Velocity:1	0.37020207	0.60844233	0.46084663	0.64024342
Velocity:2	0.02470386	0.15717463	0.06013675	0.2448527

# Progress so far - Data Loss + Cont Loss (Adam Optimizer)

## Threshold = 1E-5 (7680 Epochs, so far...), GPU Laptop

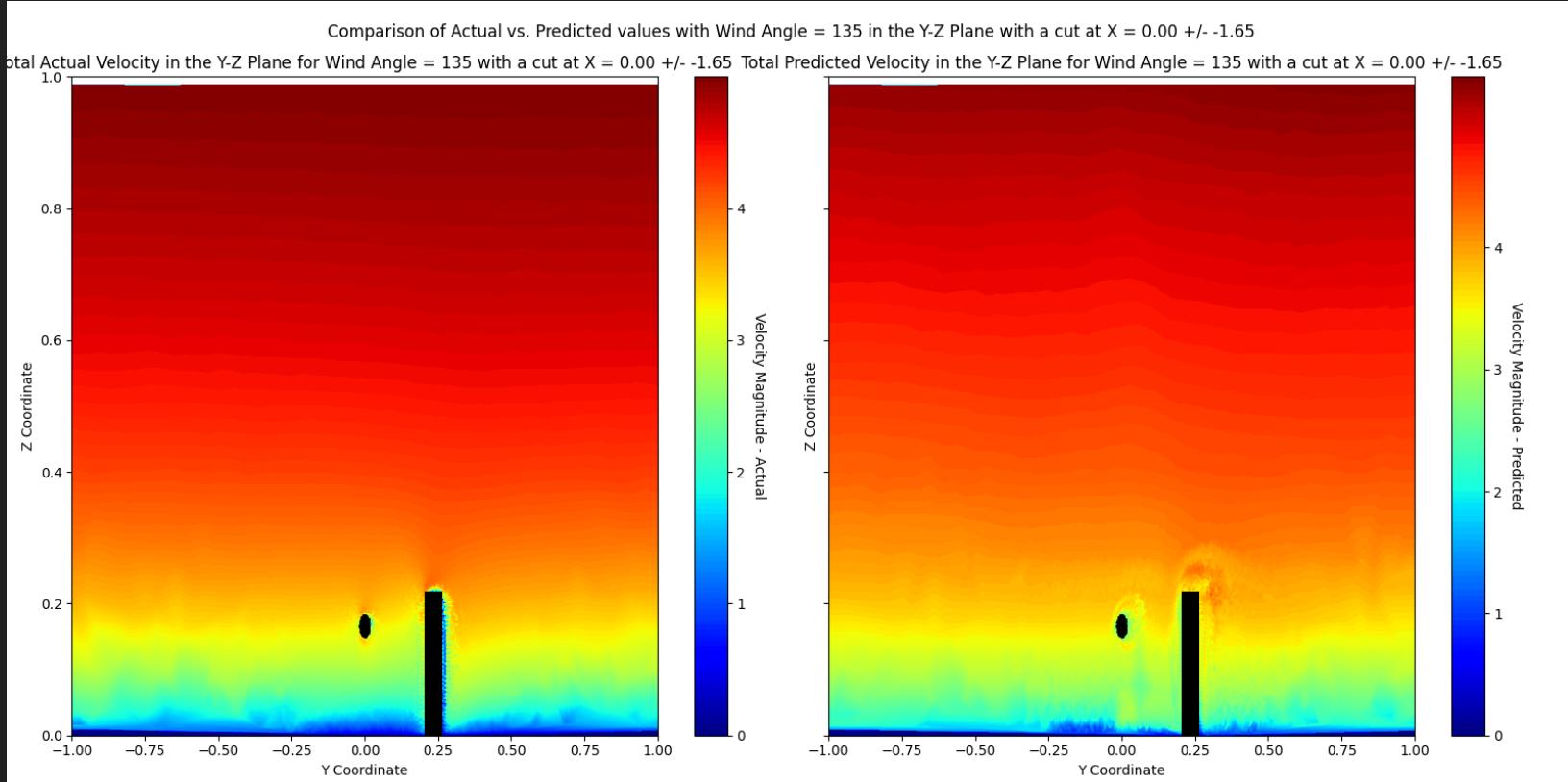
### Predicting Results - X-Y Total Velocity Plot (Angle = 135)



# Progress so far - Data Loss + Cont Loss (Adam Optimizer)

## Threshold = 1E-5 (7680 Epochs, so far...), GPU Laptop

### Predicting Results - Y-Z Total Velocity Plot (Angle = 135)



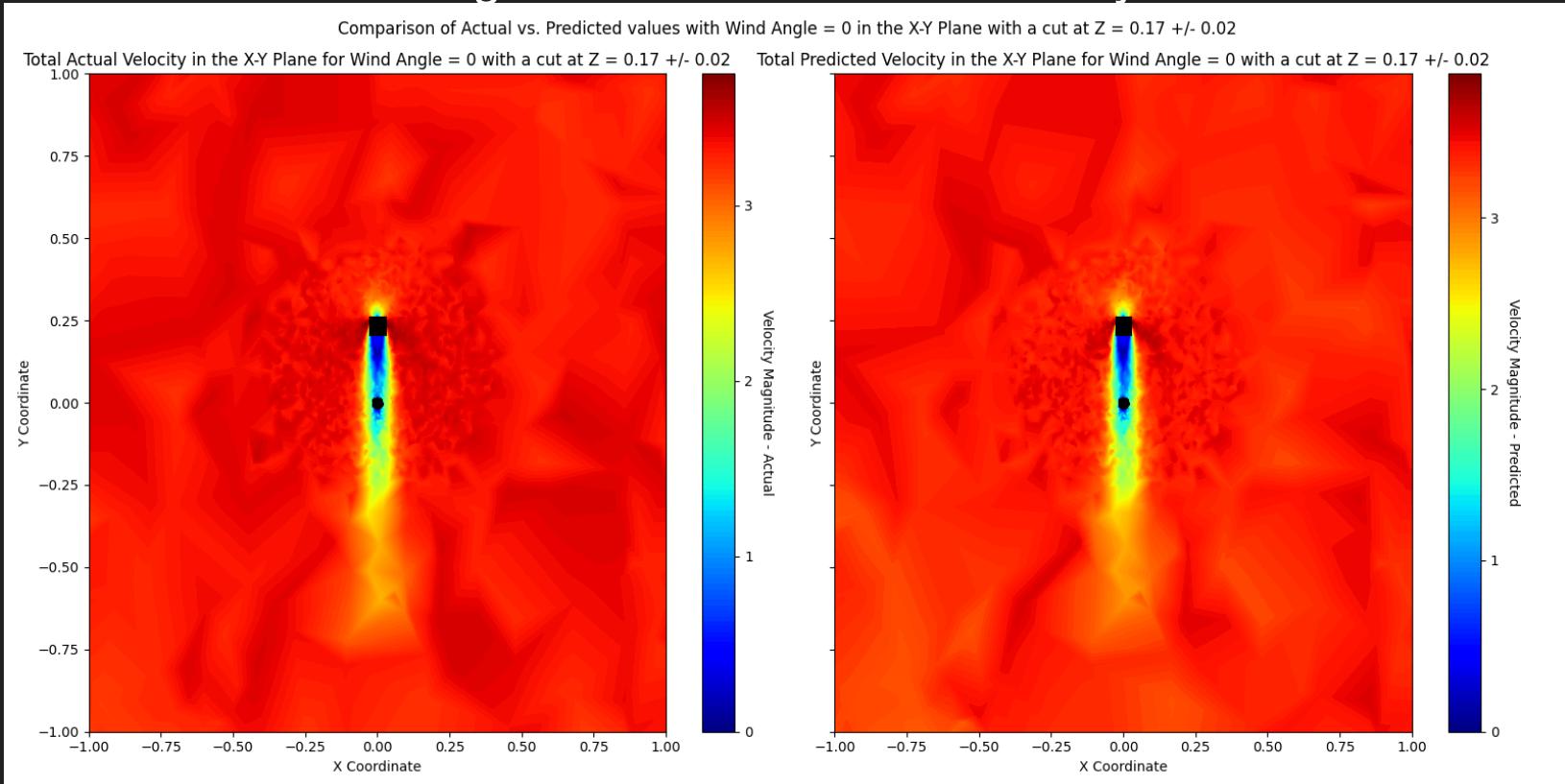
Progress so far - Data Loss + Cont Loss + RANS Loss (Adam Optimizer)  
Threshold = 1E-5 (5400 Epochs, so far...), GPU Laptop  
Testing Results - Metrics

Variable	MSE	RMSE	MAE	R2
Pressure	0.00364972	0.06041294	0.03737356	0.99922606
Velocity:0	0.00168196	0.04101172	0.02408311	0.99916676
Velocity:1	0.00385195	0.06206411	0.03741128	0.9995341
Velocity:2	0.00012084	0.01099263	0.00596333	0.99609346

# Progress so far - Data Loss + Cont Loss + RANS Loss (Adam Optimizer)

## Threshold = 1E-5 (5400 Epochs, so far...), GPU Laptop

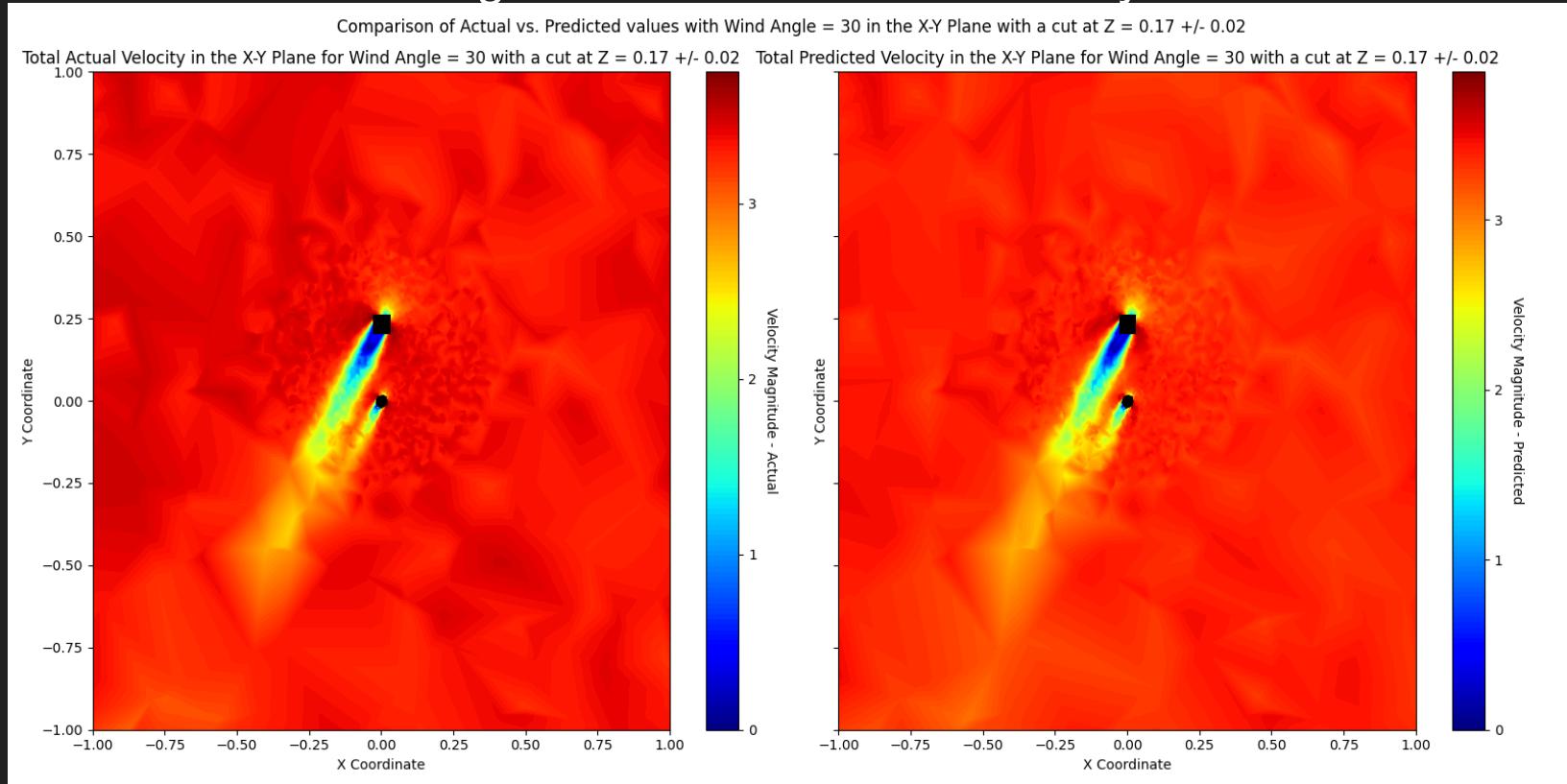
### Testing Results - X-Y Total Velocity Plot



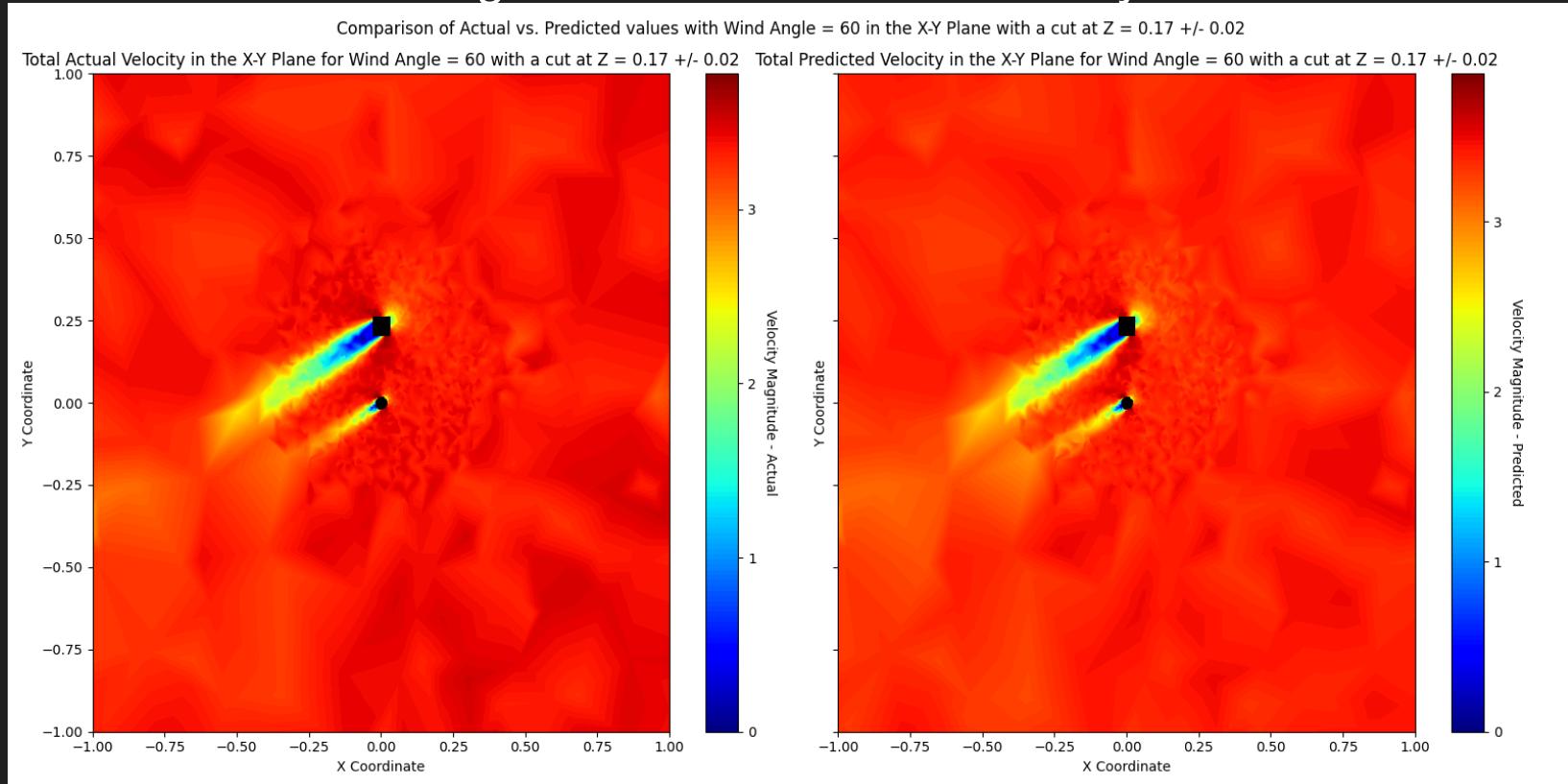
# Progress so far - Data Loss + Cont Loss + RANS Loss (Adam Optimizer)

## Threshold = 1E-5 (5400 Epochs, so far...), GPU Laptop

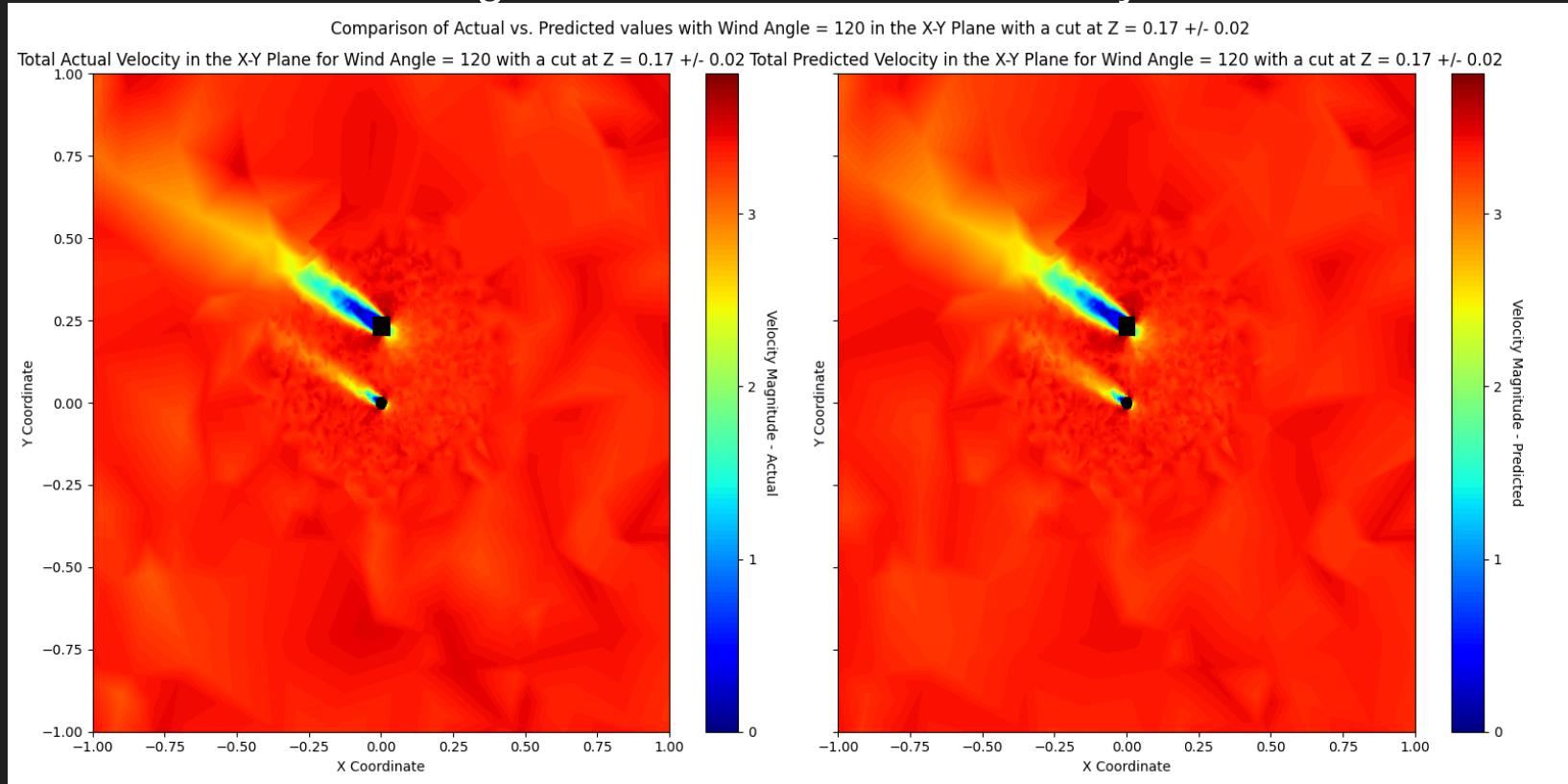
### Testing Results - X-Y Total Velocity Plot



Progress so far - Data Loss + Cont Loss + RANS Loss (Adam Optimizer)  
Threshold = 1E-5 (5400 Epochs, so far...), GPU Laptop  
Testing Results - X-Y Total Velocity Plot



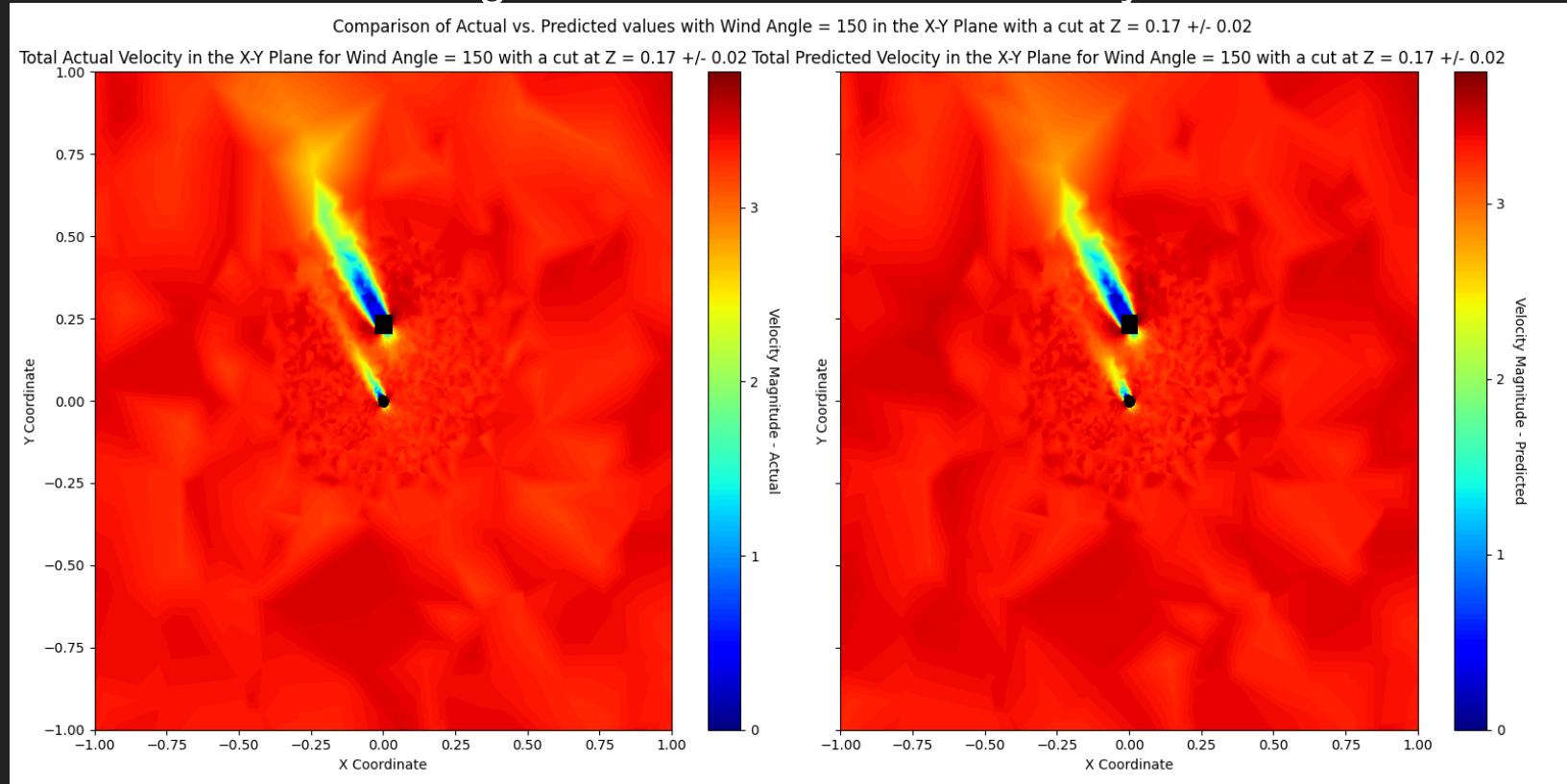
Progress so far - Data Loss + Cont Loss + RANS Loss (Adam Optimizer)  
Threshold = 1E-5 (5400 Epochs, so far...), GPU Laptop  
Testing Results - X-Y Total Velocity Plot



# Progress so far - Data Loss + Cont Loss + RANS Loss (Adam Optimizer)

## Threshold = 1E-5 (5400 Epochs, so far...), GPU Laptop

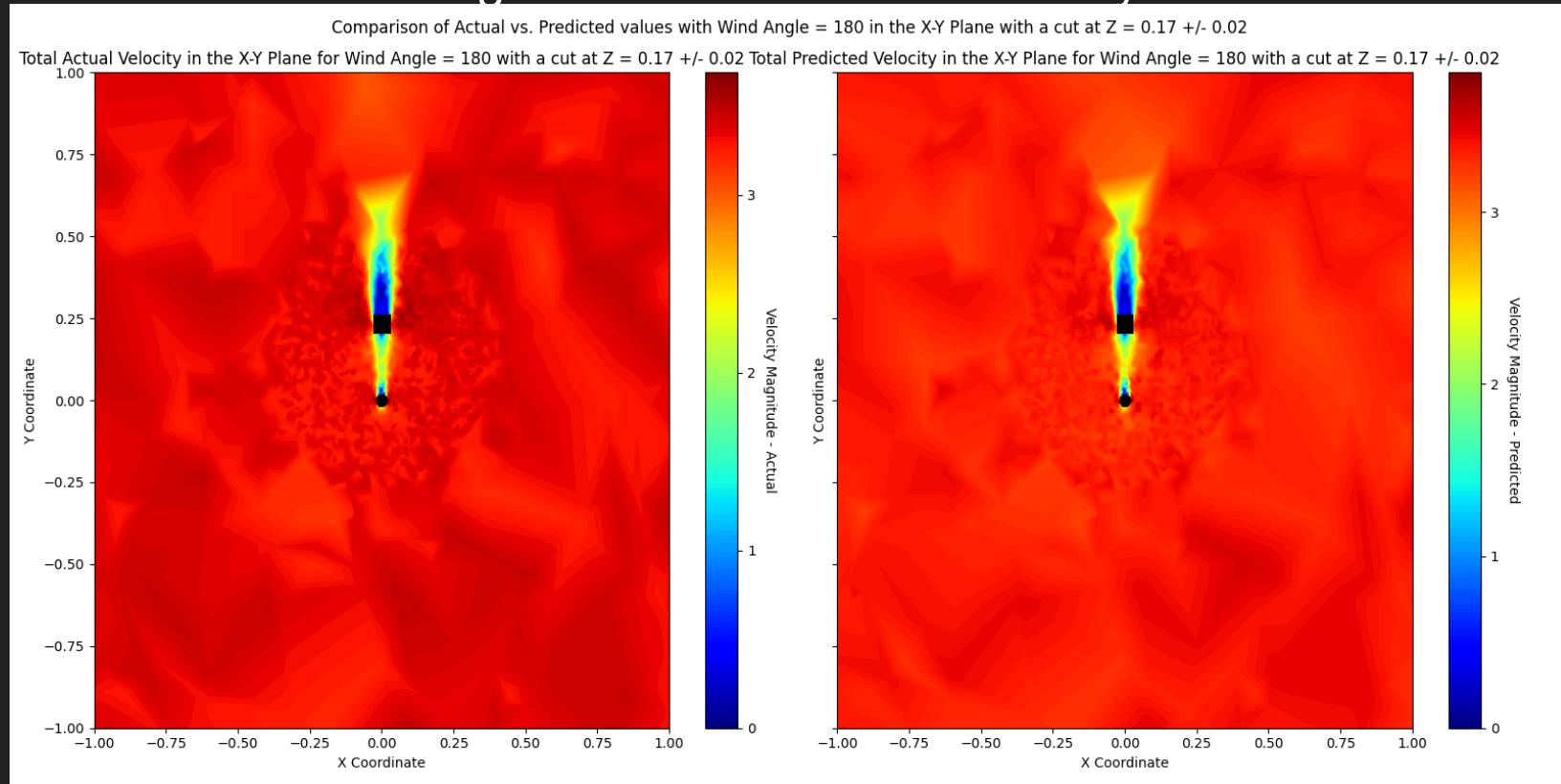
### Testing Results - X-Y Total Velocity Plot



# Progress so far - Data Loss + Cont Loss + RANS Loss (Adam Optimizer)

## Threshold = 1E-5 (5400 Epochs, so far...), GPU Laptop

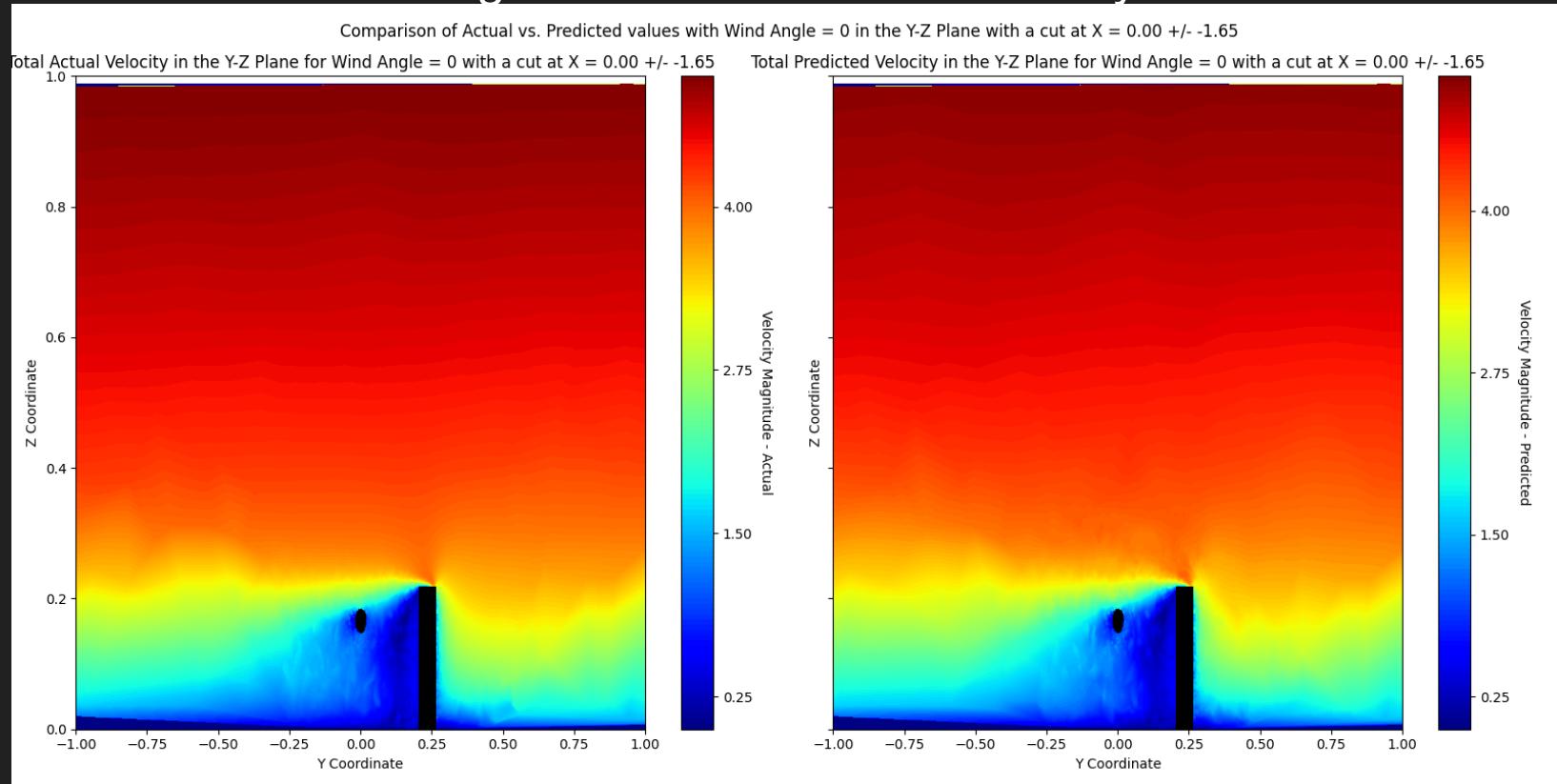
### Testing Results - X-Y Total Velocity Plot



# Progress so far - Data Loss + Cont Loss + RANS Loss (Adam Optimizer)

## Threshold = 1E-5 (5400 Epochs, so far...), GPU Laptop

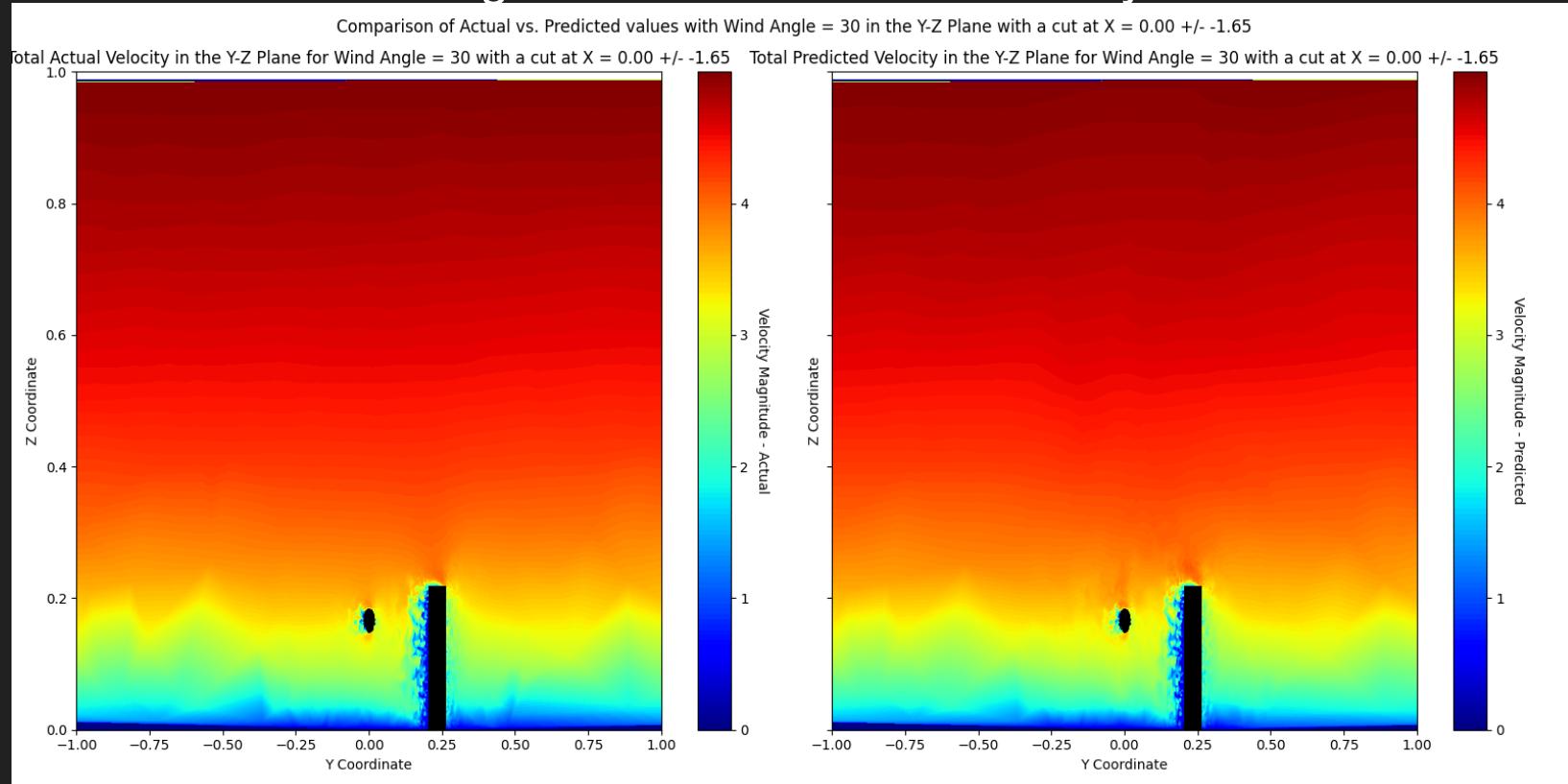
### Testing Results - X-Y Total Velocity Plot



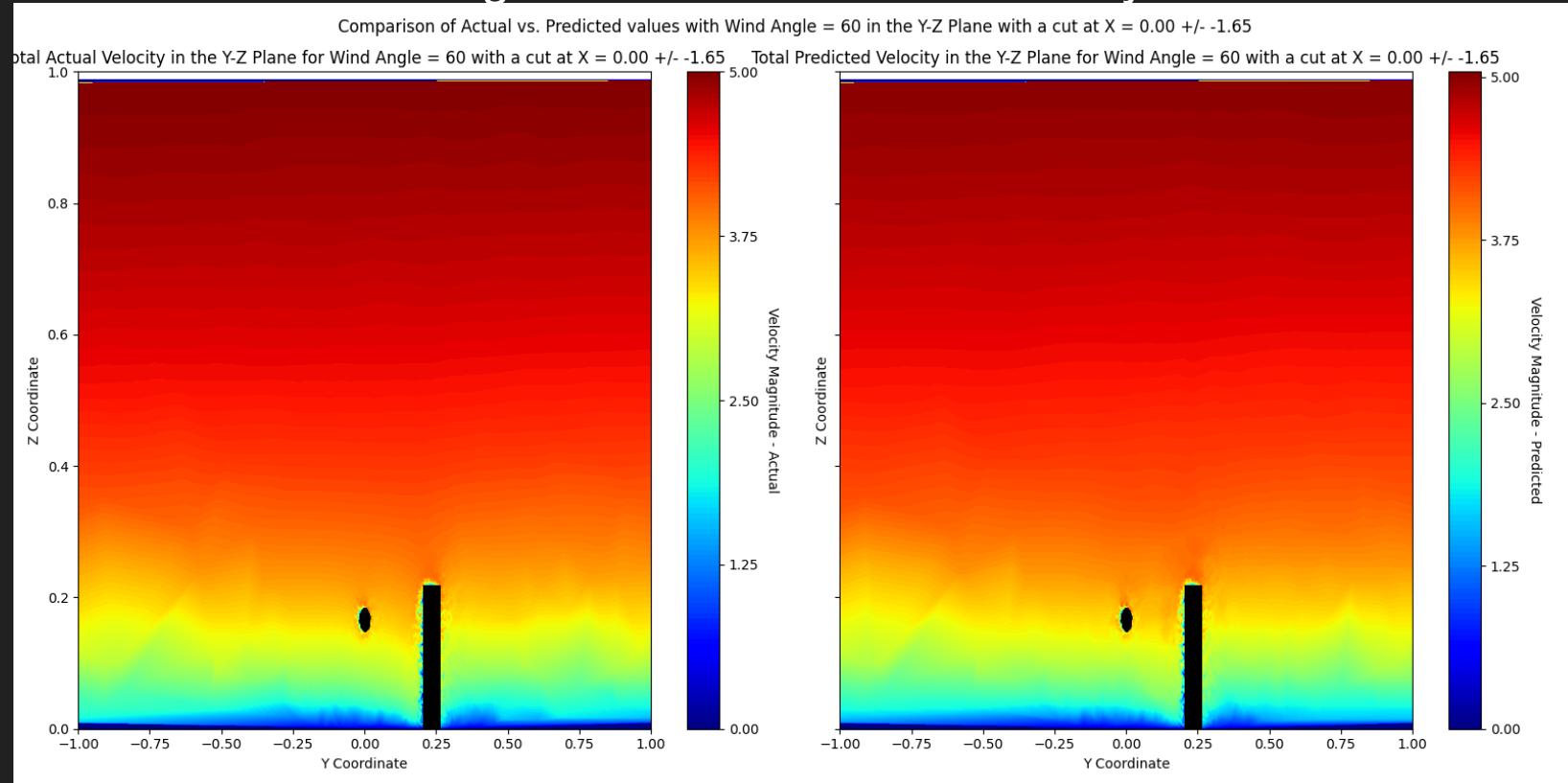
# Progress so far - Data Loss + Cont Loss + RANS Loss (Adam Optimizer)

## Threshold = 1E-5 (5400 Epochs, so far...), GPU Laptop

### Testing Results - X-Y Total Velocity Plot



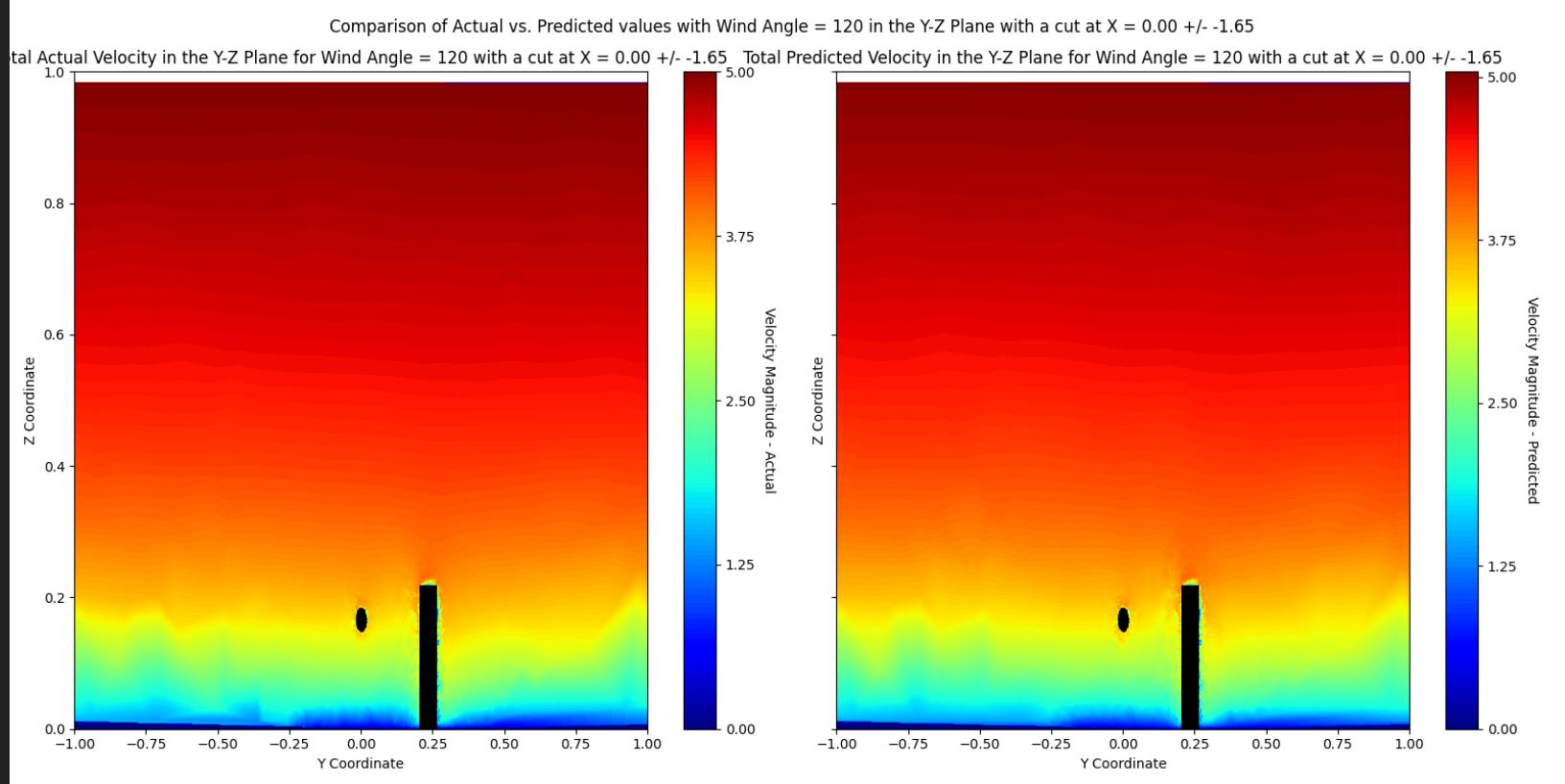
Progress so far - Data Loss + Cont Loss + RANS Loss (Adam Optimizer)  
Threshold = 1E-5 (5400 Epochs, so far...), GPU Laptop  
Testing Results - X-Y Total Velocity Plot



# Progress so far - Data Loss + Cont Loss + RANS Loss (Adam Optimizer)

## Threshold = 1E-5 (5400 Epochs, so far...), GPU Laptop

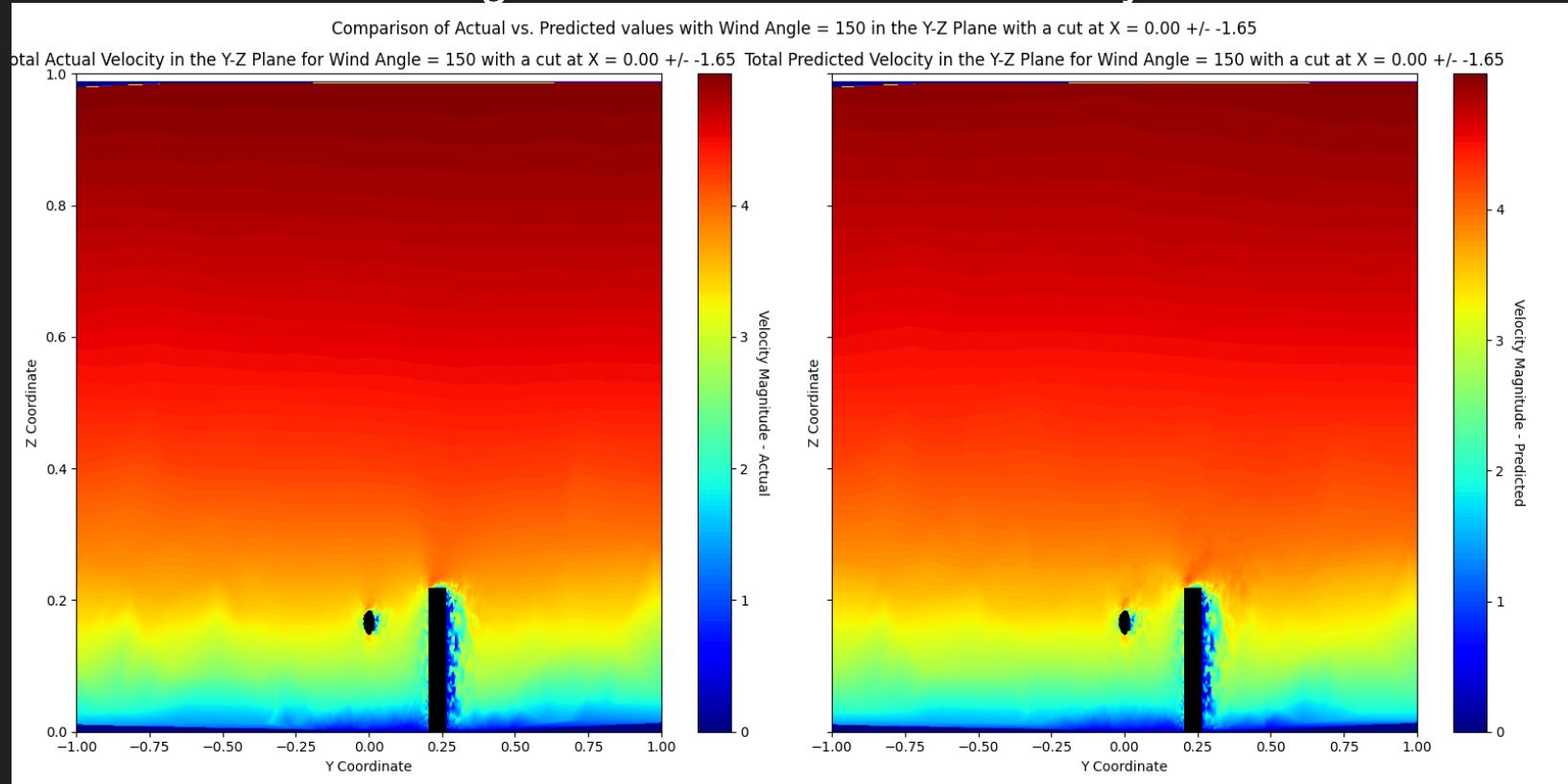
### Testing Results - X-Y Total Velocity Plot



# Progress so far - Data Loss + Cont Loss + RANS Loss (Adam Optimizer)

## Threshold = 1E-5 (5400 Epochs, so far...), GPU Laptop

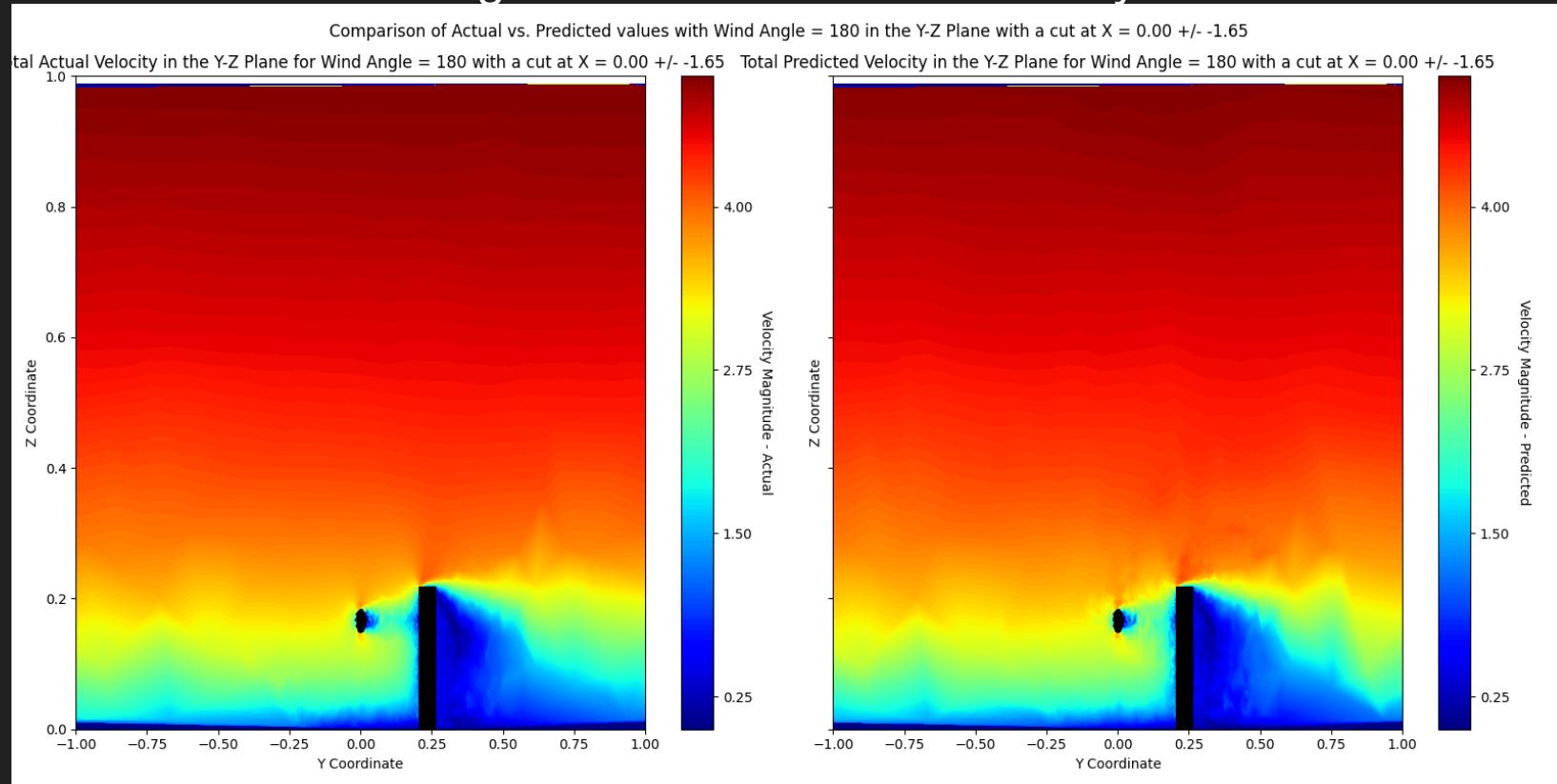
### Testing Results - X-Y Total Velocity Plot



# Progress so far - Data Loss + Cont Loss + RANS Loss (Adam Optimizer)

## Threshold = 1E-5 (5400 Epochs, so far...), GPU Laptop

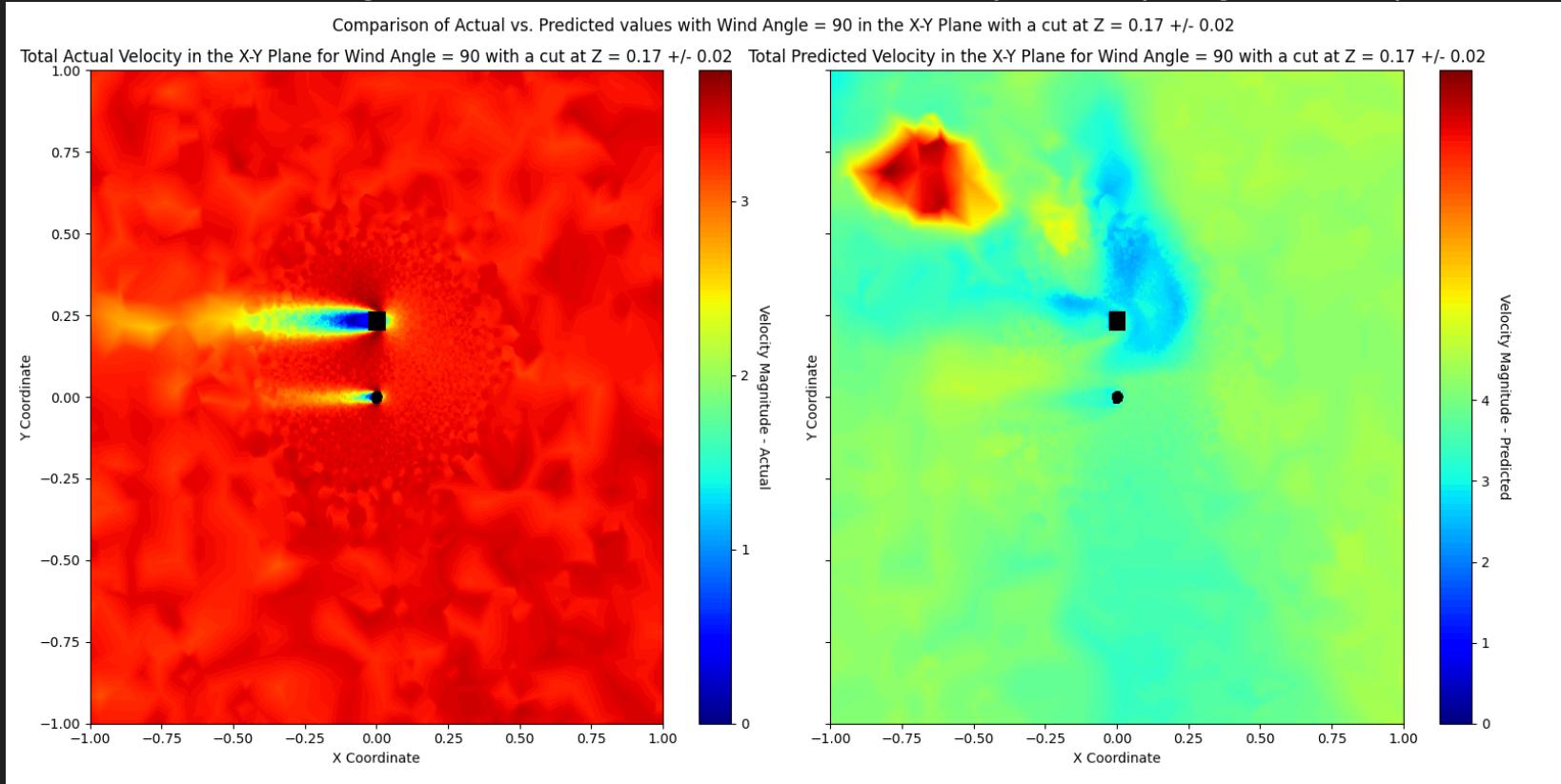
### Testing Results - X-Y Total Velocity Plot



Progress so far - Data Loss + Cont Loss + RANS Loss (Adam Optimizer)  
Threshold = 1E-5 (5400 Epochs, so far...), GPU Laptop  
Testing Results – Metrics (Angle = 90)

Variable	MSE	RMSE	MAE	R2
Pressure	29.8978071	5.46788872	3.85787731	-16.174583
Velocity:0	1.02771039	1.01376052	0.90530051	0.48208495
Velocity:1	0.61835036	0.78635257	0.5696696	-11.016773
Velocity:2	0.7911997	0.88949407	0.45162508	-22.885368

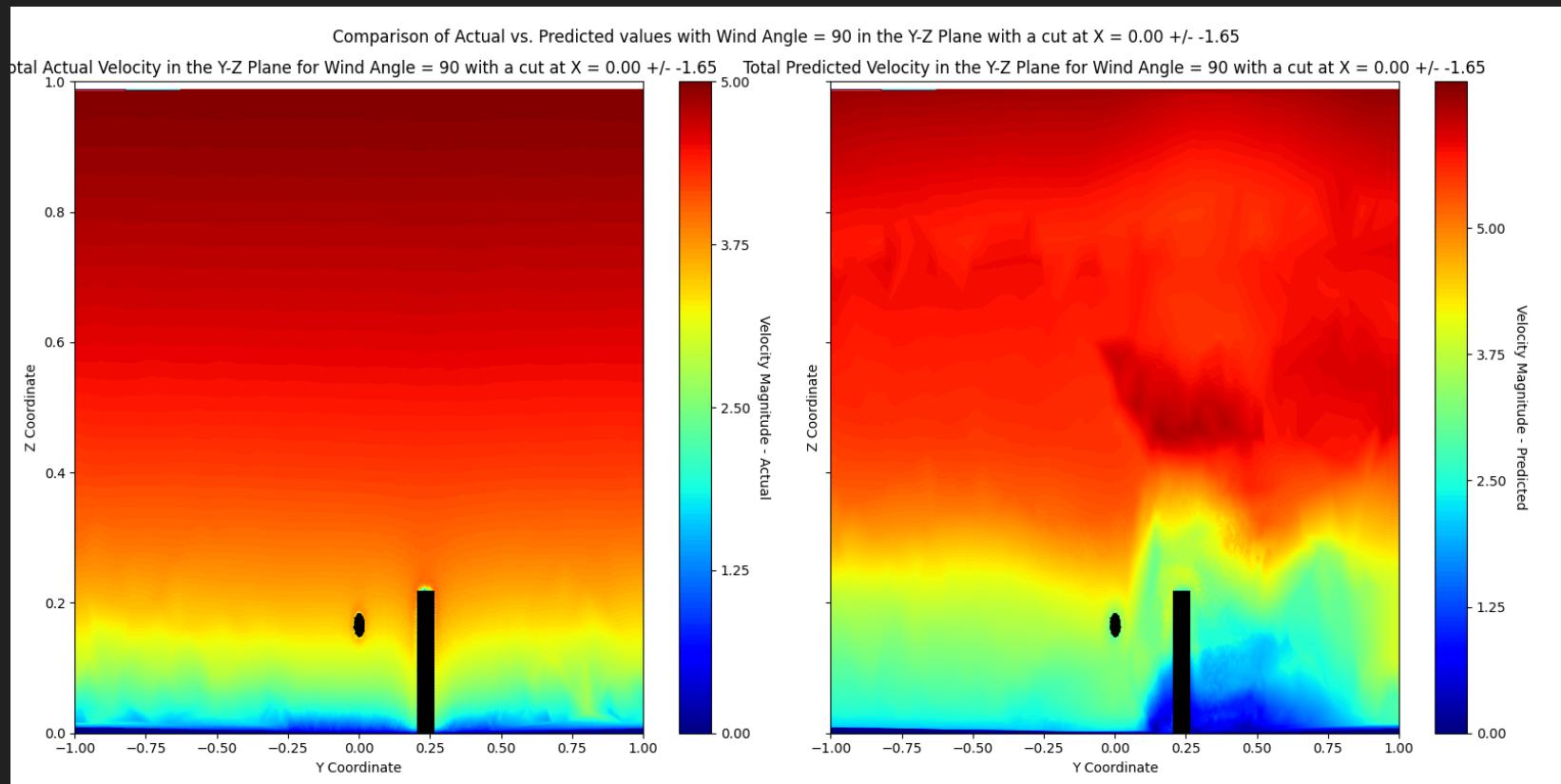
Progress so far - Data Loss + Cont Loss (Adam Optimizer)  
Threshold = 1E-5 (7680 Epochs, so far...), GPU Laptop  
Predicting Results - X-Y Total Velocity Plot (Angle = 90)



# Progress so far - Data Loss + Cont Loss (Adam Optimizer)

## Threshold = 1E-5 (7680 Epochs, so far...), GPU Laptop

### Predicting Results - Y-Z Total Velocity Plot (Angle = 90)



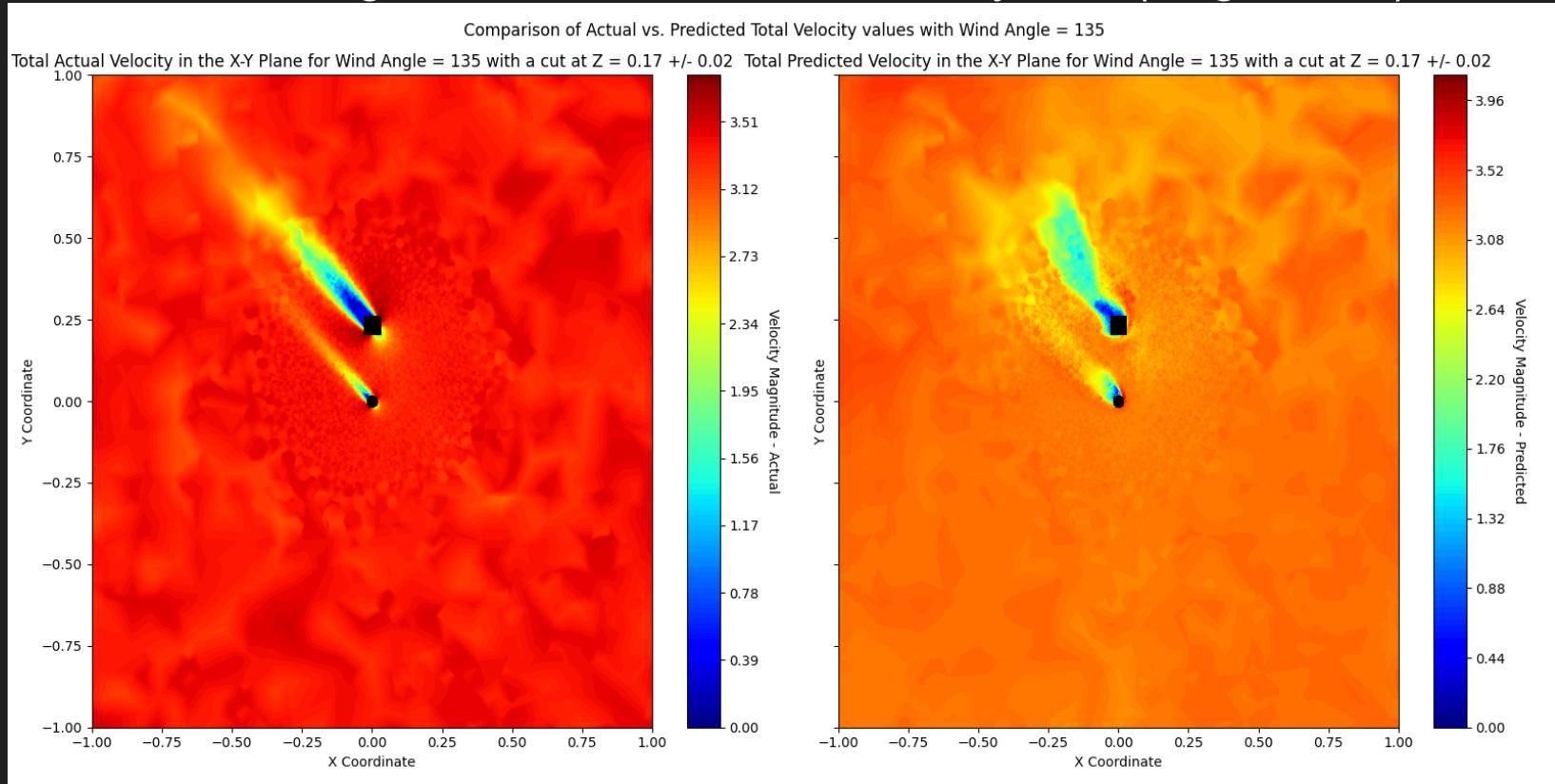
Progress so far - Data Loss + Cont Loss + RANS Loss (Adam Optimizer)  
Threshold = 1E-5 (5400 Epochs, so far...), GPU Laptop  
Testing Results – Metrics (Angle = 135)

Variable	MSE	RMSE	MAE	R2
Pressure	1.55444569	1.24677411	0.58380363	0.08040464
Velocity:0	0.28687284	0.53560512	0.38439829	0.71853807
Velocity:1	0.2985522	0.5463993	0.3817838	0.70987164
Velocity:2	0.02667502	0.16332491	0.06180706	0.1845983

# Progress so far - Data Loss + Cont Loss (Adam Optimizer)

## Threshold = 1E-5 (7680 Epochs, so far...), GPU Laptop

### Predicting Results - X-Y Total Velocity Plot (Angle = 90)



# Progress so far - Data Loss + Cont Loss (Adam Optimizer)

## Threshold = 1E-5 (7680 Epochs, so far...), GPU Laptop

### Predicting Results - Y-Z Total Velocity Plot (Angle = 90)

